ENCYCLOPÆDIA

OF

AGRICULTURE

PRINTED FOR
WILLIAM GREEN & SONS
BY MORRISON AND GIBB LIMITED
April, 1908

ENCYCLOPÆDIA

OF

AGRICULTURE

BY THE MOST EMINENT AUTHORITIES

EDITED BY

C. E. GREEN

AND

D. YOUNG

VOLUME II.

DRILLS

TO

JOINT-ILL

EDINBURGH AND LONDON

WILLIAM GREEN & SONS

PUBLISHERS

The Authors of the Principal Articles in this Volume are as follow:—

Education	R. Patrick Wright, Principal, Glasgow and West of Scotland Agricultural College.
Elder and Elm . . .	Right Honourable Sir Herbert E. Maxwell, Bart.
Electric Power . . .	Professor Malden.
Ensilage	John Speir, Newton Farm, Glasgow.
Entail	R. Geoffrey Ellis, Barrister-at-Law, London.
Enteritis	Professor Penberthy.
Entomology	R. Stewart MacDougall, D.Sc., Edinburgh.
Farmyard Manure and Feeding of Horses, Cattle, and Sheep	Professor Wrightson, Downton, Salisbury.
Fences	R. Henderson, Portland Estates Office, Kilmarnock.
Fertilisers and Feeding Stuffs Act	Max A. Robertson, Barrister-at-Law, London.
Fescues	Principal Percival, Reading.
Finger-and-Toe . . .	D. Young.
Fir	Right Honourable Sir Herbert E. Maxwell, Bart.
Fixtures	Max A. Robertson.
Flock Books	Professor Wrightson.
Flower Farming . . .	W. E. Bear, Magham Down, Hailsham.
Foaling . . . . . **Foot-and-Mouth Disease** .	Professor Penberthy.
Forage Crops . . .	Professor Wrightson.
Forestry	Right Honourable Sir Herbert E. Maxwell, Bart.
Foxtail	Principal Percival.

Frozen Meat Trade . . John Douglas.

Fruit Growing . . . W. E. Bear.

Fruit, Insects Injurious to . R. Stewart MacDougall, D.Sc.

Fungoid Diseases . . . Principal Percival.

Galloway Cattle . . . Very Rev. John Gillespie, LL.D., Mouswald, Dumfries.

Game and Game Laws . . Max A. Robertson.

Gardening . . . . T. W. Saunders, Author of *Encyclopædia of Gardening*, etc. etc.

Geology . . . . Primrose M'Connell, B.Sc., F.G.S.

Glanders . . . . Professor Penberthy.

Gleditsia . . . . Right Honourable Sir Herbert E. Maxwell, Bart.

Goats . . . . . Professor James Long.

Green-Crop Manuring . . Professor Wrightson.

Grubbers . . . . Professor Malden.

Grunting in Horses . . Professor Penberthy.

Guano . . . . . Professor Wrightson.

Guernsey Cattle . . . Professor James Long.

Hackneys . . . . William Scarth Dixon.

Half-Bred Sheep . . . Andrew S. Grant.

Harness . . . . Professor Wrightson.

Harrows . . . . Professor Malden.

Hawthorn and Hazel . . Right Honourable Sir Herbert E. Maxwell, Bart.

Hay Sheds . . . . R. Henderson.

Heather Burning . . . George Malcolm, Invergarry.

Hedges . . . . . R. Henderson.

Herdwick Sheep . . . Professor Wrightson.

Heredity and the Principles of Breeding J. Cossar Ewart, Professor of Natural History, Edinburgh University.

Hereford Cattle . . . John Hill.

Highland Cattle and Ponies . James Cameron, Agricultural Editor, *Glasgow Herald*.

Hoose	Henry Thompson, M.R.C.V.S., Aspatria.
Horse Breaking . . .	Sydney Galvayne.
Horse, Evolution of . .	Professor Cossar Ewart.
Horse Shoeing . . .	Professor Penberthy.
Hunters	William Scarth Dixon.
Hybridisation of Plants. .	John Wilson, D.Sc., Lecturer on Agriculture, St. Andrews University.
Impaction	Professor Penberthy.
Implements: Evolution of .	Professor Malden.
Irrigation	Professor Wrightson.
Jersey Cattle . . .	Professor James Long.
Joint-Ill	Professor Penberthy.

ENCYCLOPÆDIA OF AGRICULTURE

Drills.—Corn drills and seed drills depositing the seeds in rows in the ground are such a necessary part of the machinery equipment of the farm that it is difficult to realise that up to seventy years ago they were by no means in common use. Invented first by Joseph Locatelli of Carinthia in 1662, and then brought to England, it was not, however, until 1783, when Cooke's drill was brought out on lines largely followed in modern drills, that they became really known in England. Salmon's Bedfordshire drill and Smyth's Suffolk drill were introduced about 1800, and from that time they steadily spread throughout the country. From this period small improvements have been made from time to time; the draught has been lightened, various forms of "feeds" to separate constantly flowing and regulated quantities of seed from the bulk in the hopper to the delivery spouts have been introduced, and steerage has in instances been facilitated. It cannot, however, be said that the steerage has been materially improved, for Salmon's is still the most accurate drill in this respect, though its heavy draught and heavy load on the steerer when turning, and the greater skill required to balance the coulters, renders it less popular than other machines which have largely displaced it. The three main points in a drill are, that it shall sow the required quantity regularly, deposit this at an even depth, and be capable of exact steerage. Practically, all modern drills effect the two former; some, however, have no steerage attachment and their accuracy depends on the straightness with which the horses are led; others have a fore-carriage steerage which admits of accuracy in a modified degree; the back steerage is the only one by which a skilled man can make exact straightness. As the principle of the necessity for accuracy of steerage has held good from the days when Tull was the missionary of drill husbandry until to-day, because it admitted of horse-hoeing corn without the risk of cutting up the crop, steerage must be held to be one of, if not the most important, features in drill work. If the drilling is an inch inaccurate, it means that the hoes cannot be set to work so closely within an inch of the corn as they might be if the drilling were exact. It is this want of exactness, and fear of cutting up the outside rows of each draught of the drill, that prevents so many farmers from using the horse-hoe when it might otherwise be used with great advantage. Greatly as drills have been improved in all other respects, there is still the need of more easily directed steerage in modern drills.

Drills are conveniently divided into the following classes:—(1) Cup drills, where the corn is placed in a big upper hopper, from which it passes with some regulation to a lower, smaller hopper or box, containing a spindle carrying a number of discs, about the periphery of which are placed series of spoon-shaped cups which measure out the grain (regulated by change

wheels controlling the speed of the spindle), which falls into the delivery spouts and hence into the track made by the coulter, and so deposited into the soil.

(2) The tooth and brush pinion drills, where the revolving spindle carries circular brushes which sweep out the seed through holes pierced near the bottom of a triangularly shaped hopper.

(3) Disc drills, which are somewhat similar to brush drills, except that the pinion is replaced by a disc having waved edges, and with alternately open and close holes at the bottom of the discs bringing some seed forward at the same time, after the manner of the endless screw.

The aforesaid drills are uncertain on hilly land, and the first-mentioned is irregular on rough cloddy ground.

(4) Chain feed drills, which carry the seed from the hopper on an endless chain to the spouts; not much affected by hillsides, but somewhat uncertain and irregular in delivery.

(5) Force feed drills, which until comparatively recently were not very popular in Britain because of a liability to crack or crush the seeds; but are fast gaining popularity, since effective means have been adopted for releasing the grains when being forced through the aperture. This, on the whole, is the most reliable feed. Several makers make their drills so as to be readily converted from one feed to another according to the wish of the purchaser.

(6) Liquid manure drills, in which the manure is placed in a tank along with water, and emptied by a suitable cup feed.

(7) Potato drills, where cups on an endless band convey the potatoes separately to the delivery spouts. An ingenious machine, made by Ransome, Sims, & Jefferies, was awarded first prize in R.A.S.E. trials at Leicester. In this case the hopper is made somewhat in the form of an inverted cone, but a portion of the cone is occupied by a rotary disc (very similar to the ordinary form of root pulper). A series of mechanical hands are placed near the edge of this, and each hand enters the bottom of the hopper with the claws open; when partly through the hopper the claws close, holding a potato, which it carries round to a convenient place to allow it to fall, then the arm of the hand is withdrawn by a cam, the claws open, and the potato falls. The machines are made with moulders to open up the ridges, and with coverers to turn the soil back, so that the whole process of planting is accomplished in one operation.

The main difference between a broadcast distributor and a drill is that after the seed or manure leaves the hopper, and after it is "fed" so as to regulate the quantity, it is conducted in the case of the drills into spouts or funnels conveying it to the track made by the coulter; whereas with distributors it falls evenly over the whole surface.

With manure drills, which are mainly used for the root crop, it is usual to attach a seed box, so that the manure and seed may be deposited at one operation.

Drying Racks.—Although used in Scandinavia and some other countries, drying racks or light frameworks against which or upon which wet or sappy crops are placed are little used in Great Britain for ordinary agricultural purposes, though they are employed for drying oak bark, willow wands, and other materials requiring long exposure. Granting that there is no better way to dry produce than by raising it above ground, so that air may circulate freely about it, still the fact that but a small quantity of

material can be dried in unfavourable harvesting weather, unless a very large area of drying frame be provided, prevents any general use of the system, except on very small holdings. A farmer with a large number of sheep hurdles may place these so as to form a line Λ shape, or other convenient form, with little expense, but in a climate such as Great Britain possesses, where reasonable opportunities for harvesting are to be expected, it does not pay to erect frameworks, except for crops more valuable than corn or hay. It is better to use machinery which facilitates harvesting, and to employ methods which prevent serious injury from wet.

Ducks.—*See* Poultry.

Dung.—*See* Farmyard Manure.

Dunlop Cheese.—*See* Cheddar (Scottish).

Durham Cattle.—A name frequently applied in North and South America to shorthorn cattle, which were originally called Durham or Teeswater cattle. *See* Shorthorns.

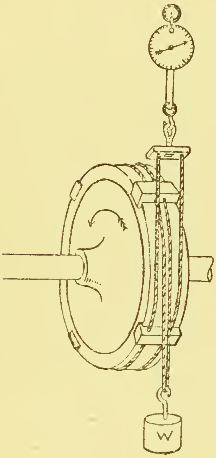
Dutch Cattle.—In former times it was quite a common thing for dairymen to import Dutch cattle which were the native breed of Holland. But the frequent epidemics which prevailed in that quarter led to the trade being closured many years before the passing of the Diseases of Animals Act in 1895 (*see* Diseases of Animals Act). Most of these Dutch cattle being bought by dairymen would be milked during the season and then parted with. It so happens, however, that a few herds exist in this country which consist almost entirely of pure-bred Dutch cattle which have been bred off the stock originally imported. These are for the most part a good class of milking and beefing cattle of good scale. They are invariably of a mixed black-and-white colour, the legs, underline, and a greater or less part of the body being usually white. The cows are usually heavy milkers, but the quality of their milk is rather variable, some giving a heavy yield of rather poor milk, while others give an equally heavy yield of rich milk. They are rather largely used as dairy cattle in America, and at the World's Fair, held at St. Louis in 1904, a representative of this breed was awarded the palm for butter-production. One of the largest herds of pure-bred Dutch cattle in this country is that of Mr. Brown, Marden Park, Hertford.

Dynamometers.—A dynamometer is an instrument for measuring the force exerted by a machine or animal.

The simplest example of a dynamometer in everyday use is a weighing machine which measures the force with which the earth attracts the article we wish to weigh; and the most useful form for general purposes is a spring balance, owing to its compactness and to the fact that it can be used in any position. Another example of a dynamometer is an ordinary steam gauge which measures the force with which the steam is pressing on every square inch of the interior surface of the boiler to which it is attached. In practice, however, we generally want to know more than the mere force exerted by an animal or machine; we also want to know the rate at which that force is being applied, in other words, the power exerted; for instance,

directly a horse puts its weight on to the traces it is exerting a force, but it is not giving out power until it starts to move forward. To find the power being exerted we must multiply the pull in lbs. shown on the dynamometer or spring balance by the speed in feet per minute. This gives us the power in foot-pounds per minute, and if we divide the figure so obtained by 33,000 we get the horse-power exerted. This figure of 33,000 foot-pounds per minute is supposed to represent the rate at which a strong horse can work steadily for eight hours a day, and was determined by Watt, the inventor of the steam-engine, from a study of the brewers' dray horses in London, which were capable of maintaining a steady pull of 150 lb. at a rate of 220 feet per minute—$2\frac{1}{2}$ miles per hour.

To take a practical example: an agricultural motor is drawing a six-furrow plough at a speed of 3 miles per hour (*i.e.* 264 feet per minute); if we put a spring balance between the motor and the plough, we find the pull to be, say, 15 cwt. (*i.e.* 1680 lb.), then the horse-power that is being exerted on the plough is—



$$\frac{1680 \times 264}{33{,}000} \text{ or about } 13\tfrac{1}{2} \text{ H.P.}$$

It is important to remember that the dynamometer by itself does not give the power but only the tractive force; thus the same motor might give a dead pull of 25 cwt. or more in starting the plough out of the ground; in the same way the horse is capable of exerting a much greater pull than 150 lb., and frequently does so when starting a heavy load; though the power in each case might be less.

Dynamometers are frequently employed for measuring the brake horse-power of engines, and the type generally employed is known as "absorption dynamometers," or more simply "brake dynamometers." A common form consists of a belt or rope wrapped round the fly-wheel or pulley of the engine to be tested, with a spring balance at each end, or sometimes with a dead weight at one end and the spring balance at the other; the difference between the two spring balances, or between the dead weight and the spring balance, gives the force applied at the rim of the fly-wheel or pulley. If the speed of engine is known, the horse-power is easily calculated thus:

H.P. = force applied at rim in lbs. multiplied by the circumference of the wheel in feet, multiplied by the revolutions per minute, and divided by 33,000.

The illustration shows one arrangement commonly employed. When the engine is at rest the whole of the weight is taken by the spring balance; when the engine is running, the friction of the rope on the pulley tends to lift the weight W and relieve the spring balance. The load applied is easily altered by adding weights on to W.

There are many other forms of dynamometers, such as the "Torsion dynamometers" for measuring twisting forces; "Transmission dynamometers" for measuring the power being transmitted by belting, shafting, etc., but these will seldom come under the notice of the agriculturist.

Ear-Marking.—The practice of ear-marking sheep is an ancient one, and doubtless at first consisted of nothing more than a uniform notching of the ears in each separate flock, as a means of establishing ownership in stolen or strayed sheep.

At the present day the need for an ownership mark which can be distinguished at a distance, without handling the sheep, has led to the almost universal plan of marking the fleece; whilst ear-marking has been reserved for a separate purpose.

In systematic sheep-breeding it is important that the shepherd should be able to determine the age, career, and pedigree of any particular member of his flock, and that can only be done with certainty if he has an infallible means of identifying each individual sheep.

In practice, the plan of assigning consecutive numbers to the sheep is the simplest and best means of attaining this end, as it enables the flock-master to obtain any particulars he needs by reference to his flock-book register. The ear of the sheep offers a convenient means for marking it with a distinctive number, and this may be done in one of several ways. Three systems only, however, are in common use, namely :—

1. Notching and punching.
2. Tattooing.
3. Attaching a metal tag.

The relative advantages of these systems may now be noticed.

Reserving the first for more detailed consideration hereafter, we shall first deal with the other two systems.

Tattooing is effected in a simple manner by the use of a special instrument having the desired number arranged in the form of a series of metal points, which at one operation are driven into the substance of the ear. The pigment may be either fed to the points before they are driven in, or subsequently rubbed into the punctures. Indigo and Indian ink are the pigments most commonly used.

Tattooing if done with care answers well with white-eared sheep, but it is obviously unsuitable for numbering sheep with black ears. Thus it can never be universally applicable.

There is also the likelihood that a certain proportion of the sheep tattooed will not have received sufficient careful treatment to render the mark distinct. Hence we find one authority stating, "It would be wise to make mistakes absolutely impossible by duplicating the numbers by means of the notching system."

A method which embodies so great an element of uncertainty as to call for a separate safeguard to supplement its efficiency, is clearly far from perfect.

The tag system.—This consists in attaching to the sheep's ear a metal tag, on which the number is stamped. Many different forms of tag are in use. The commoner type is a flattened ring of metal ribbon, which is passed through a hole punched in the ear near the lower margin, and close to the head, the ends being then closed together. This has been found to drop out and to cause festering, troubles which it is claimed are precluded by the "lock-ear tag," a patented adaptation of the simple tag, in which a metal sleeve is slipped over and fixed upon the free ends of the ring, thereby preventing them from unclosing, and from chafing the puncture in the ear.

Another form of tag is fashioned like a stud, one side of which carries a disc on which the number is stamped.

Although silver-plating has been practised with a view to prevent ill-

effects from chafing, it does not appear that that, or any other precaution, can entirely prevent these effects.

The presence of a hard metallic body, confined by the comparatively thin structure of the sheep's ear, must inevitably cause injury under the ordinary vicissitudes of a sheep's life in the field, and such injury may, and often does, lead to local festering and occasionally to death by blood poisoning.

Notching and punching.—This is a system which, if carefully practised, should meet every requirement. It consists in expressing the sheep's

number by means of notches in the margin of one or both ears, supplemented by perforations when necessary.

Five cardinal positions on each ear are selected, namely, two on the upper margin, two on the lower margin, and one on the tip.

Notches at these points express the numbers from 1 to 5 in passing from the root to tip along the upper margin and back along the lower margin of the left ear, and from 10 to 50 (progressing by tens) in similar positions on the right ear. By those notches alone, singly or in combination, any number from 1 to 165 can be expressed; but as the full complement of notches is hardly desirable in any one case, in practice they are only used up to 99, and are supplemented by punctures one in the centre of each ear, standing for 100 and 200 in the left and right ears respectively. To give two examples, the number 165 would be expressed thus:

165

and 227 thus:

227

The simplicity of this system and the scant opportunity it offers for careless work go far to recommend it, whilst the notches and punctures are permanent and unmistakable.

The work of notching may be expeditiously done by means of suitable nippers and the perforating by means of a lever punch.

It is clear that, once the notches have healed, they cannot subsequently prove a source of danger or discomfort to the sheep.

It is unfortunate that all sheep-breeders have not adopted the same system of placing and reading the notches, and thus there is an element of confusion whenever sheep are transferred from one owner to another. This, however, is no defect of system, but rather the result of its faulty application, and it is obvious that it might be removed by the adoption of a uniform notation.

Ear-marking is usually done at the time of weaning the lambs, at which time the flock-book entries should be made against the numbers allotted to each animal.

Early Maturity.—The great aim of every breeder of stock intended for the use of the butcher is to develop early maturity. The records of the ages and weights of cattle exhibited at the leading fat stock shows invariably prove to demonstration that cattle under two years old show a larger gain of live weight per day than those over that age. Keeping these facts in view, the wise breeder selects the best and "thriftiest" of his cattle to breed from, mates them with a well-bred sire, keeps his young stock well as calves, and rapidly pushes them forward, so that they shall go away fat to the butcher at from twenty to thirty months old. He knows full well that if he can get his young stock made ripe for the fat market at twenty-four months old, they will pay him much better than if he had to keep them on till they are thirty months old or more. So great has been the improvement in breeding cattle within recent years, and so notable has been the demand for "baby beef," that the age at which home-bred cattle are now marketed has been sensibly diminished. Of course in Ireland, where there are always large supplies of really good cattle, the young stock are sent to this country at different ages, to meet the wants of different customers. Some buy them in as calves, and by good feeding they get these animals made ready for the fat market at little if anything over the age at which home-bred stock are marketed. Others buy their Irish stores as yearlings or as "six quarter olds," and these are rather later in being got ready for the fat market. But many feeders prefer to buy two-year-old Irish cattle, and with a hard winter's feeding and abundance of concentrated feeding stuffs, they usually make as much off these cattle in six months as the graziers made by keeping them in a half-starved condition for the previous two years. The same remarks apply to sheep. The breeder of commercial sheep aims at producing animals which will grow rapidly and lay on flesh, so as to be ready for the fat market in the earliest possible time. He knows very well that the more lambs he can get away fat the better they will pay him. The demand for early maturity has been greatly quickened by the better demand for fat lambs, and in good seasons, when there is abundant grass and sunshine, the best of his lambs go away fat, while the more backward of the lot are left for "hogging." The change that has come over the spirit of flockmasters in this respect is remarkable. In the "seventies" and preceding years any one would have been laughed at had he proposed that any hill lambs should be made ready for the fat market, and "three-year-old wether mutton off the hill" was a spell to conjure with in the selling of mutton. But now the "three-year-old wether mutton" is as extinct as the Dodo, and a large proportion of the best hill lambs are

passed into the fat market by the time they are eight to twelve months old, while only a very few of them live to be over eighteen months old. Of course this again is due to the steady improvement in the class of sheep now kept, or, in other words, to the development of early maturity. The same thing also holds good with pigs. Well-bred and well-fed pigs can be rapidly made fit for the fat market, and the earlier the age at which they are made ready the greater is the profit realised by them.

Earth-worms (*Lumbricus*).—These are found universally throughout our gardens, pastures, and arable fields. They are harmless, and afford food for birds, moles, hedgehogs, and other wild animals. They are connected with the formation of mould in pastures, and are accountable for the absence of stones on the surface of all old pastures. This subject received special attention from the great naturalist Charles Darwin, who devoted his last work to "vegetable mould and earth-worms." The innumerable "casts" which cover the surface of pastures and lawns in moist weather are produced by earth-worms, which are to be seen in large numbers at night, if the observer is provided with a lantern. They withdraw instantly into their burrows when disturbed, but always leave their traces in the form of "worm sprouts." This action, continued night after night, and year after year, produces a layer of vegetable mould of fine texture, and entirely devoid of grit. The sprouts abut upon and are thrown over fragments of stone or pottery, and gradually hide them from view. The process is accompanied by subterraneous action, so that the stones are not only covered but undermined, and sink by their over weight. The process is continuous, and at length results in a deposit of several inches in depth of that fine black mould characteristic of old grass land. The richness of old pasture land, and its peculiar consistency, is due in a great measure to the earth-worms. Turf contains a large proportion of vegetable matter owing to the decay of grassy roots, but the unctuous and impalpable character of the soil is due to its having passed and repassed through the bodies of worms. The digestive system extends the entire length of the body, including a mouth, pharynx, œsophagus, crop, gizzard, and intestine, which is continued to the vent at the posterior end. The worms feed upon half-decayed leaves and flowers, and leaf and flower stalks, but consume large quantities of earth, from which they extract organic nourishment; and after passing through the gizzard, where it is finely triturated, the residue is expelled in the form of earth sprouts. They swallow grit in order to supply their gizzards with grinding power, and to assist in the reduction of what they consume to the fine condition in which it exists in the castings. In fertile soils worms attain a larger size, and present a healthy, fleshy appearance; but in poor soils they are small, and often of bad, greenish colour. They have therefore been considered an indication of the quality of land. The habits and instincts of worms have been studied, and are highly interesting. Worms are easily alarmed, and possess a keen sense of hearing or sensibility to the slightest vibration of the surface. Their burrows are lined with a layer of fine dark-coloured earth, and extend downwards, either perpendicularly or obliquely. The worm when extended on the surface usually keeps its flat muscular tail within the orifice of its burrow, and retracts its body into safety on the slightest alarm. That Darwin should have written a volume entirely upon these creatures is a proof of their interest to naturalists, and there is no doubt that worms exert important functions in the improvement of pastures,

and the covering and protection of ancient monuments such as tesselated pavements.

Education (Agricultural).—Under the designation of agricultural education is properly comprised the whole course of training and instruction by which a young man is prepared or made qualified to undertake successfully the business of farming. In common custom the term "agricultural education" is, however, very commonly though erroneously employed to designate only instruction in what was formerly, and in view of the state of comparative ignorance then prevailing, not, incorrectly, called the theory, as distinguished from the practice of agriculture. In more recent times, thanks to the great advances made in scientific knowledge during the "wonderful century," the term "theory" has been in large measure abandoned in favour of the word "science," and agricultural education is very widely supposed to mean education in the natural sciences and their application to agricultural practice. This, however, is obviously an incorrect and much too narrow an interpretation. Agriculture is primarily an art, and only secondarily a science. The education of a farmer, to be thorough and complete, must of necessity comprise a training in both the art and the science, the practice and the theory of agriculture. But so far as the overwhelming majority of farmers in Britain are concerned, agricultural education in both its main divisions has always been and still remains defective. On the scientific side, up till quite recent years, it may be generally said that it was wholly neglected. On the practical side, some education was always of necessity given or obtained, but neither in former times, nor now, has it ever been systematic, thorough, or complete.

Of necessity, however, practical training in the art of agriculture has always been given, and up to a certain point given efficiently and satisfactorily. A sailor cast on a desert island like another Robinson Crusoe would soon teach himself, apart from any previous training, the arts of fishing and hunting, and, even perhaps in some elementary fashion, the art of agriculture. A sane man in whose hands a spade was placed for the first time would hardly fail soon to learn the proper method of digging; and Adam in the Garden of Eden could need no other guidance than the use of his own hands, eyes, and brains, to teach him in time the rudiments, at any rate, of the art of "dressing and keeping" it. In regard to much of the practice of agriculture, the same methods still hold true. In some measure they are self-discovered and self-taught by each successive generation of young farmers. But this, of course, is not wholly, nor indeed mainly, true. The practical art of agriculture is learned mainly by imitation. The young farmer growing up on a farm sees what is being done by his predecessors and elders. He works with them, and learns to do as they do, and to see as they see. He learns to plough as his father ploughs, to sow as his father sows, to reap when his father reaps, and in course of years of imitation and observation, and according to the measure of his capacity, the son approximates to the standard he has followed, and becomes in his turn such a farmer as his father was before him.

Even in regard, however, to the art and practice of agriculture, it is obvious that this is a very narrow and insufficient course of training. The student who is to be taught an art successfully requires to have the best models set before him, and however far the average student may fall short of attaining to them, he will rise to a much higher standard of attainment

than if the models he had followed had been themselves far below the standard of perfection. But it would be absurd to expect that every farmer's son who was learning to imitate his father's practice and his father's methods was necessarily learning from a good model. A man is not necessarily a good farmer because he happens to be a father, and he might indeed be a model father while very far from being a model farmer. Yet his son, who learns only his methods, his practice, and his ideas, is assumed thereby to have acquired a thorough knowledge of the practice of agriculture. It is true, of course, that a young man's opportunities of observation are not confined wholly to his own farm. He meets his neighbours, sees their farms, attends markets, and has intercourse with other farmers. In such ways he picks up further odd scraps of information, but his farming remains that of his district, and his knowledge extends little further.

The defects of such a course of practical training—and it is the course that has been always hitherto followed by nearly all the farmers of Britain—are both those of "omission and of commission." Of commission, because the errors of the father's practice, his erroneous ideas and his prejudices, are all likely to be continued in the son. Of omission, because the practice of agriculture on every farm is more or less incomplete. The range of crops grown is limited, the live stock comprise only a few breeds, the soil may be of one kind only, the climate has its special features which regulate the practice of the district, but which teach a practice that may probably be not only useless, but positively injurious, if carried to and applied in some other part of the country to which the son may remove.

The insufficiency even of the practical training acquired on one farm has, however, been always recognised, and in giving directions for the education of young farmers, some of the older writers advise that the young farmer should spend two years on an arable clay farm, two years on a light land arable farm, and two years more on a mountain sheep farm; after which, says one, with some reason, "he must have a very competent knowledge of that part of agriculture known as farming or husbandry." But such directions are only of value to sons of merchants, and others not brought up on farms, but who have decided to become farmers. For farmers' sons, who form the great majority of the future farmers, such variety of practical training is rarely or never provided. It is the universal practice to assume that the experience gained on his father's farm forms a sufficient preparation for the young farmer's life-work, and if he is obliged, as very commonly happens, to move to a new farm in a remote district, he has very frequently to pay heavily in new experience for the deficiencies of his early education.

It must be pointed out, however, that even the variety of experience gained on several farms would not of itself constitute a complete course of instruction, even in practical farming, however it might be superior to the experience gained on one kind of farm only. It would still suffer in the former case from the defects inseparable from any method of instruction that is not imparted thoroughly and systematically. In every case, the young farmer would be mainly dependent for what he learned on his own aptitude and on his own powers of observation. In the important qualification, for example, of knowledge of the points of live stock, in nine cases out of ten the young farmer at the end of his apprentice course, even if prolonged in the manner recommended, might easily remain a very incompetent judge.

It is, however, when attention is turned to the theory or the science of agriculture that the deficiencies in our methods of agricultural education become most apparent. Practical knowledge, even if it were made much more

complete than it actually is, could never make a man a thoroughly competent farmer. "The pupil," as one writer puts it, "by carefully imitating all around him may become a very expert monkey, but unless he learn a reason for every operation, he will never farm like a rational being." The most thorough practical training in the art of agriculture that can be given is liable to this charge, and though in actual practice, among an intelligent and inquiring people, theories are formed and reasons are given more or less fully and more or less correctly for the practices commonly followed, it nevertheless remains true in general, that what constitutes an avowedly practical knowledge of agriculture is in large measure empirical, unintelligent, and such as must retard all advances or improvements in the business of farming. A farmer, who merely works according to the routine he has been taught, will not, and cannot with safety, readily change his methods, for he is without the knowledge of principles which would enable him to distinguish between those changes that would be for the better and those that would be for the worse. He knows that foolish and reckless change may lead to his ruin, and as he is unable to determine what changes are for his advantage he holds steadfastly on the middle way of routine practice, which means stagnation in his art. Hence the slow progress of agriculture for eighteen centuries, at the end of which the art of cultivating the soil was no better understood than it was during the most prosperous halcyon days of the ancient Roman Empire. True it is, though hardly credible, that at the end of the eighteenth century, in an empire even vaster, the words of the Roman author were as applicable as when they were first written. "Nothing equals my surprise," he says, "when I consider that while those who desire to learn to speak well, select an orator whose eloquence may serve them as a model; while those who are anxious to dance, or become good musicians, employ a dancing or a music master;—in short, that while every one looks for the best master in order to make the best progress under his instructions, the most important science, next to that of wisdom, has neither pupils nor teachers. I have seen schools established for teaching rhetoric, geometry, music, dancing, etc., and yet I have never seen a master to teach agriculture, nor a pupil to learn it."

The honour of making the first attempt in Great Britain to institute courses of systematic instruction in the theory or science of agriculture rests with Scotland and with the city of Edinburgh. In the year 1790, Sir William Pulteney founded in the University of Edinburgh a Chair of Agriculture. The first professor, Dr. Coventry, was a Doctor of Medicine and the proprietor of a landed estate in Kinross-shire, which he farmed himself, and he therefore combined in himself such a knowledge as was possible at that time of natural science and agricultural practice. He occupied his chair for nearly forty years, and during that period no further steps were taken to develop agricultural education in Scotland, and it was a number of years later, about 1840, that a lectureship in agricultural chemistry was also established in the Marischal College, Aberdeen.

In England the need of education in agriculture was also being recognised, but it was not till 1845, more than half a century after the foundation of the Edinburgh Chair of Agriculture, that there was founded at Cirencester in Gloucestershire the first English Agricultural College, which has been known since the year 1880 as the Royal Agricultural College. A large capital was provided by subscriptions of landowners and others, a farm was attached to the college, and courses of instruction were provided, not only in the sciences relating to agriculture, but also in practical farm work. Later in the century one or two isolated agricultural colleges or

schools were formed in other parts of the country, but it was not till the year 1882 that agricultural education received any State recognition in England. In that year a Lectureship in Agriculture was instituted by Government in the Normal School of Science, London, and special courses of instruction in the science of agriculture were provided for teachers from country schools. These courses were intended to qualify school teachers to give elementary instruction in agricultural science in evening classes in rural schools; and in the same year the Science and Art Department included the Principles of Agriculture among the subjects on which teachers could earn grants on pupils who had made a specified number of attendances on the classes, and who had passed examinations held by the Department. This new step gave a great stimulus to the teaching of elementary agricultural science throughout the whole of Britain, and for the first time in its history gave it something of a national character. Moreover, the institution of these classes led to the publication of numerous text-books of agricultural science designed to prepare students for the Science and Art examinations. The earliest of these, by the late Professor Henry Tanner, were written in a very excellent popular style, easily comprehensible by those who had little or no knowledge of science, and they did much to disseminate a knowledge of what the teaching of agricultural science really meant. Nevertheless the influence of the Science and Art schemes remained limited in extent. Only a small proportion of the rural schoolmasters qualified themselves to teach the subject of agriculture, and as the number of classes and pupils increased, the standard of the examination was raised, and it became more and more difficult to earn such grants from the passes of the students as would remunerate the teacher for the labour undertaken by him in the conduct of the classes. The progress of the Science and Art schemes was therefore automatically checked by their own success, while they had still touched but a fringe of the vast field that lay open to the efforts of the educationist.

Further State recognition of agricultural instruction commenced in the year 1888, when the Treasury made a direct grant of £5000 to be expended annually in its aid. The control of this grant was subsequently transferred to the Board of Agriculture, which was instituted in the following year. In the year 1896 the control of the Treasury grant in aid of agricultural education, so far as it relates to Scotland, was transferred to the Scotch Education Department, while the Board of Agriculture still continued to administer the grants in England, and also to give grants for purposes of research to the whole of Britain. The grants made available for such purposes gradually increased, and amounted in England alone in the year 1905–06 to £10,655.

The commencement of the establishment of a system of agricultural education, national in its aim, and destined in course of time to develop into a completely organised system in all parts of the kingdom, dates, however, from the year 1890, when, under the Local Taxation (Customs and Excise) Act, 1890, there were placed at the disposal of each of the County and Town Councils in Britain, large sums, which were to be devoted by them either to the reduction of local rates or to the promotion of technical education. Considerable hesitation was at first shown by these Councils in undertaking the new responsibilities unexpectedly thrown on them for the development of technical education, and a large proportion of the grants was applied for some years to reduce local taxation. But more rapidly in some counties, more reluctantly in others, schemes of technical, including agricultural, education were evolved, and the sums expended on these purposes have undergone a steady increase. It has been mainly through the gradual evolution of the various County Council schemes, and the

arrangements made by them with existing schools and colleges, or by the formation of entirely new institutions, that there has now been established throughout Britain a network of institutions and lectureships, which cover the whole country, and bring agricultural education in one or other of its branches more or less completely within reach of all farmers' sons. The satisfactory and rapid development of this system in the closing decade of the nineteenth and the first decade of the twentieth century marks that era as one of outstanding importance in the history of British agriculture.

The actual expenditure incurred by the County Councils of England and Wales in aid of agricultural education in the year 1905–06 was £83,987, and, with the addition of the grants from the Board of Agriculture, the total amount was £94,642. The rapidity of the progress made is best realised by considering that prior to 1888 there were no funds at all available for expenditure on such purposes.

The exact position in England may perhaps be best understood from the list of institutions at present in receipt of aid from the Board of Agriculture. The following particulars are extracted from the Board's Annual Report on the Distribution of Grants for the year 1905–06 :—

List of Grants awarded 1905–1906.

Name of Institution.	Work.	Grant, 1905–6.	Date when Institution commenced Agricultural Teaching.[1]
		£	
University College of North Wales, Bangor	Agricultural Instruction	800	1889
Do. do.	Farm	200	
Do. do.	Forestry	250	
University of Leeds	Agricultural Instruction	800	1891
Do.	Farm	200	
Armstrong College, Newcastle-on-Tyne	Agricultural Instruction	800	1891
Do. do.	Farm	200	
Do. do.	Forestry	250	
University College of Wales, Aberystwyth	Agricultural Instruction	800	1890
Do. do.	Farm	200	
Cambridge University	Agricultural Instruction	800	1893
Do.	Farm	200	
University College, Reading	Agricultural Instruction	800	1893
Do. do.	Farm	200	
South-Eastern Agricultural College, Wye	Agricultural Instruction	800	1894
Do. do.	Farm	200	
Midland Agricultural and Dairy College	Agricultural and Dairy Instruction	600	1895
Do. do.	Farm	200	
Harper Adams Agricultural College	Agricultural Instruction	300	1901
College of Agriculture and Horticulture, Holmes Chapel	Do.	200	1895
Agricultural and Horticultural College, Uckfield	Do.	200	1894
Essex County Technical Laboratory	Do.	200	1892
Harris Institute, Preston	Do.	150	1892
British Dairy Institute, Reading	Dairy Instruction	300	1896
Eastern Counties Dairy Institute, Ipswich	Do.	300	1889
National Fruit and Cider Institute	Do.	300	...
Cumberland and Westmoreland Farm School	Agricultural and Dairy Instruction	100	1896
Hampshire Farm School	Agricultural Instruction	100	1900
Ridgmont Agricultural Institute	Do.	100	1895

[1] Compiled from information supplied by the Institutions.

It will be seen from what has been already stated, that the maintenance of all these institutions is mainly dependent on local funds derived from fees, County Council grants, and other sources, and that the direct grant from the Board of Agriculture is only an aid, which constitutes a variable, and in every case only a limited proportion of the total cost.

In Scotland, the grants to the Agricultural Colleges were given up to the year 1907 by the Scotch Education Department on a different principle. The Department agreed to defray the half of the total annual expenditure of the institutions, after deduction of fees, provided always that the local contributions from all sources did not amount to less than one-half the expenditure claimed on. On this principle the grants given to the three Scottish Agricultural Colleges, which are the only institutions in Scotland to which aid is given by the Department for agricultural instruction, were as follows, in the year 1905–06 :—

Name of Institution.	Amount of Grant.	Date of Foundation of Institution.
	£	
Aberdeen and North of Scotland College of Agriculture .	2285	1904
Edinburgh and East of Scotland College of Agriculture .	2030	1901
West of Scotland Agricultural College, Glasgow . .	2935	1899

It appears from these figures that there are now in receipt of State aid in Britain, in all twenty institutions engaged in giving instruction in agriculture, besides a few other colleges, which, on account of the nature of their constitutions, or for other reasons, receive no contributions from the Treasury grants. It is obvious, however, that if the work of each of these institutions was confined to the classes taught within its walls, the number would be quite inadequate to bring such instruction within suitable access of farmers and farmers' sons throughout the kingdom. But the Agricultural Colleges differ in general from other educational institutions in that they are recognised to be the centres of higher agricultural education in the provinces in which they are situated, and they not only hold classes within the walls of the central college buildings, but also organise and provide courses of instruction adapted to the requirements of farmers in any part of the geographical areas of which they form the centres, and conduct or supervise any similar classes that may be locally arranged. Thus the South-Eastern Agricultural College in Wye provides for the requirements of the counties of Kent and Surrey; the Leeds University for the county of York; and the Midland Agricultural and Dairy College for the counties of Nottingham, Leicester, Derby, and Lincolm. The whole of Wales is provided for by the University Colleges of Aberystwyth and Bangor, and the whole of Scotland by three colleges situated respectively in Aberdeen, Edinburgh, and Glasgow. The work of each of the colleges therefore divides itself naturally into two main sections—(*a*) internal, and (*b*) external, that is the conduct of the classes held in the college buildings, and the arrangements made for instruction in agricultural science throughout the areas supervised by the colleges, for those who are unable to attend the central classes. In addition to this there are departments in the colleges which, apart from directly educational work, are intended to

assist farmers who cannot become students, by giving them information and advice on points of ordinary farm practice, and by conducting field and other experiments, which are useful both for purposes of demonstration and of research. The nature and extent of the work undertaken by the larger of these colleges may be shown by one or two examples.

In the West of Scotland Agricultural College the full course of study provided in the central buildings covers a three years' course of study, which enables students to qualify themselves to take the diploma of the college, and also to present themselves for the examinations for the national diploma in agriculture.

The subjects of study during the three years required for the college diploma are similar to those of the national diploma.

Shorter courses of study of from one month to two years' duration are also arranged for students who can only afford a limited time for attendance on college classes, while in connection with the College Dairy School, and to enable students to qualify for certificates in dairying and the national dairy diploma, there are courses of instruction in practical dairy work, including cheese- and butter-making, and courses of classes in dairy science, extending over varying periods up to two years.

In conjunction with the University of Glasgow the college also provides the classes required for the B.Sc. degree in Agriculture in the university. This course of study represents the highest standard required in Britain for this degree, and, along with preparation required for the examinations for the National Diploma in Agriculture, can hardly be completed in less than four years. It is as follows. Students must first of all pass the preliminary or entrance examination, after which they must attend at the Agricultural College and the University the following twelve subjects, and pass examinations in them :—

(1) Mathematics or Biology (Zoology and Botany); (2) Natural Philosophy; (3) Chemistry; (4) Agricultural and Rural Economy; (5) Agricultural Chemistry; (6) Geology; (7) Veterinary Hygiene; (8) Agricultural Botany; (9) Agricultural Entomology; (10) Economic Science; (11) A course in one of the following—(*a*) Forestry, (*b*) Experimental Physics, (*c*) Engineering; (12) Engineering Field Work.

In their extension work the colleges endeavour to bring their influence to bear on the farmers resident within the area associated with them, by conducting experiments on the farms themselves, as well as on the experiment stations connected with the central institutions, by giving demonstrations on these experiments, by printing and circulating reports on their results, by delivering numerous lectures in local centres, and by conducting classes in practical dairying, farriery, and other subjects in rural villages or on farms.

Thus the University College, Reading, has associated with it an experimental farm for purposes of agriculture, which includes a garden for experiments and demonstrations in horticulture. Its external work in 1905–06 comprised the delivery of courses of lectures in six centres in Buckinghamshire; single lectures and short courses of lectures in seventeen centres in Dorset; short courses of lectures in eight centres in Oxfordshire; and field experiments carried out on twenty-five farms distributed over the same counties. In Kent the extension work of the South-Eastern College comprised a travelling farriery school, which gave practical instruction in horse-shoeing. In Yorkshire, instruction, theoretical and practical, in the same subject was also arranged for in four centres by

the Leeds University, under which there were also given between seventy and eighty short courses of lectures on agriculture, horticulture, poultry-keeping, and veterinary science, in numerous centres scattered over the county; while demonstrations in butter-making and soft cheese-making were given at fourteen centres.

Such are the methods by which the agricultural colleges endeavour to make their influence felt by the whole farming community, while at the same time they provide for the requirements of the most advanced students. The measure of their success may be judged from the Board of Agriculture estimate that 34,000 persons in England alone had come in 1905–06 under the influence of these courses of instruction. It cannot, however, be said that perfection of organisation has yet been attained, or that there is no room for further development. On the contrary, it is generally recognised that much still remains to be done, especially in the widespread provision of elementary instruction suited to prepare pupils for the higher courses in the agricultural colleges, and accessible in all parts of the country to young men intending to follow the business of farming. But in regard to higher agricultural education the provision now made throughout Britain may be regarded as quite abreast of the national requirements, while the inducements offered to capable students to make their courses of study complete, in the forms of diplomas and degrees, are also ample. In addition to those offered by the several institutions to their own students, the national diplomas in agriculture and in dairying, which are given by a joint committee of the Royal English Agricultural Society and the Highland and Agricultural Society, are honours open to all students either of Britain or Ireland.

The examinations for the national diploma in agriculture are divided into two parts, which comprise the following subjects:—

First Part.

(1) Agricultural Botany.
(2) Mensuration and Land Surveying.
(3) General Chemistry.
(4) Geology.
(5) Agricultural Zoology.

Second Part.

(6) Practical Agriculture.
(7) Agricultural Bookkeeping.
(8) Agricultural Chemistry.
(9) Agricultural Engineering.
(10) Veterinary Science.

The history of agricultural education in Ireland has been very different from that either of England or of Scotland. As early as the year 1838 the Commissioners of National Education instituted a State-supported School of Agriculture at Glasnevin, near Dublin, about five years before the first agricultural college was founded in England, and education in agriculture was provided in it for schoolmasters and young farmers. The Commissioners subsequently established a number of model agricultural schools and farms, of which there were altogether at one time as many as 115 in operation. The numbers, however, gradually diminished, till in 1874 there were, exclusive of Glasnevin, only twenty remaining The attendance at these was so small that a committee of inquiry, appointed by the

Treasury, recommended their abolition, and shortly thereafter there remained in Ireland no agricultural or dairy schools save those of the Albert Institution, Glasnevin, and the Munster Dairy School near Cork. These institutions continued to maintain a successful and useful existence till the end of the century, when a fresh attempt was made on a large scale to provide Ireland with a complete and thorough system of agricultural education. This attempt was initiated by the new Department of Agriculture and technical instruction, and the commencement of its efforts may be dated from the year 1900.

The Department first of all made a thorough inquiry into the requirements of the country, and thereafter formulated a policy, which has since been energetically and steadily followed. Their objects, as stated by Professor J. R. Campbell, in the evidence given by him before a Departmental Committee of Inquiry, were:

(1) To provide at one central institution the highest form of technical education for the training of men who were to become teachers and specialists in agriculture.

This has been done at the Royal College of Science, Dublin, acting in connection with a farm and college at Glasnevin, a few miles outside Dublin. One of the first steps taken by the Department was to institute a Faculty of Agriculture in this college and to provide in it a course of study in agricultural science extending over three years, and corresponding closely to the similar courses existing in the British colleges, as already described. It is now, however (1907), in contemplation to extend this course to cover a four years' period of study. The special object is to train men fitted to become teachers of agricultural science, and a number of scholarships are given by the Department to suitable men, which are of sufficient value to cover the cost of living and the whole expenses of the students' education.

(2) To provide at least one high-class agricultural college which would form a stepping-stone to men desirous of entering the Royal College of Science as well as sons of farmers desirous of qualifying themselves to become creamery managers, experts in poultry or in horticulture, and land agents, or who desired merely to acquire such a knowledge of agricultural science and practice as would make them better qualified for the management of their own farms.

Such an institution was ready to the hand of the Department in the Albert Agricultural College, Glasnevin.

(3) To provide provincial institutions at which farmers' sons could be given a one year's course of instruction in agricultural science and practice at a very moderate cost.

Three such institutions have now been formed by the Department—at Athenry, in County Galway; at Ballyhaise, in County Cavan; and at Clonakilty, in County Cork.

(4) To provide winter schools of agriculture where the sons of farmers could obtain technical instruction at a small cost in the winter months.

In the year 1905–06 there were twenty-three such schools distributed over eleven counties. The course of instruction in these various centres varied in duration from eight to twenty-one weeks, two meetings as a rule being held weekly.

(5) To provide one central higher institution for the training of women in the domestic economy of the farm-house, dairying, poultry-keeping, and other work that commonly falls to women in the management of farms.

This training is given in the Munster Institute, Cork.

(6) To provide agricultural education for girls at residential and other

schools of domestic economy. A number of institutions make this provision.

(7) To provide in each county instruction and advice for the existing farmers, and their wives, sons, and daughters, who cannot avail themselves of other means of acquiring information, by a system of itinerant instruction in agriculture, horticulture, dairying, poultry-keeping, and bee-keeping.

Such is a summary of the comprehensive scheme of agricultural education which has been developed so rapidly in the first seven years of the century that almost every district of Ireland has been already embraced within its scope. Under these is provided instruction for every class of person associated with the work of agriculture, while the system is so graduated that aspiring and capable pupils, whose interest is first aroused by the itinerant instruction, may proceed to the winter school, from which they can go on to the provincial agricultural school, and finally, should they be desirous to obtain the highest qualifications in agricultural science, may pass on to the prolonged course of study provided by the Royal College of Science.

Alike in Britain and in Ireland, therefore, the past twenty years have marked the development of a system of agricultural education which must soon produce a marked effect on the practice of agriculture and on the efficiency of those pursuing it, and which, it is to be hoped, will enable the island kingdom, if not to excel all other peoples in the art of farming, at least to take a position as advanced in agriculture as it has held during the past century in commerce and colonisation.

Eel Worms.—*See* Corn and Grass Pests.

Elder (*Sambucus*) belongs to the Honeysuckle family (*Caprifoliaceæ*), being the only genus in that order with pinnate leaves.

The Common Elder (*Sambucus nigra*), called in Scotland the bourtree (=bore-tree, from the ease with which the pith is bored out of the branches), is one of the commonest woodland growths in all three kingdoms, being a good shade-bearer.

"A small tree or shrub, with the stem and branches full of pith. *Leaf-segments,* 5–7, ovate, pointed, 2–3 inches long, regularly and sharply toothed, and nearly glabrous. *Flowers,* white or cream-coloured, in flat corymbs, 5–6 inches broad; bracts very minute. *Fruit,* black." (Shortened from Bentham.)

Indigenous to England and Ireland, but considered by Bentham to be only introduced in Scotland, where, however, it is thoroughly naturalised; and the occurrence of the old Gaelic name *trom,* gen. *truim* (trim), modern *troman,* Manx *tramman,* in place names so far apart as the river Truim in Strathspey and Castramon and Trammond Ford in Galloway, seem to be evidence of its being truly indigenous.

The elder is seldom worth the planter's attention, but may sometimes be used with advantage as a windbreak for young woods in bleak exposure. Naturally it propagates itself by seeds; but, if required for the above-mentioned purpose, may be had more rapidly by setting young shoots as cuttings. Usually found as undergrowth, it takes advantage of free head-room to grow into a tree 25–30 feet high, and, when loaded with its large corymbs of flowers is a very beautiful object. The timber of old trees is

very hard and close-grained, resembling boxwood, and applicable to similar uses.

The elder is the subject of much folk-lore, neither more nor less edifying than such matter usually is; but its medicinal properties have long been in repute. From the flowers, which contain a volatile oil, an ointment is prepared, and also elder-flower water, esteemed as a cosmetic; the berries yield a not unpalatable wine.

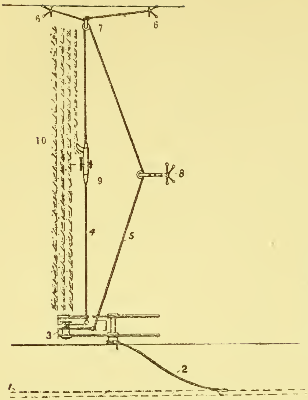
The cut-leaved variety (*laciniata*) is sometimes planted for ornament, and the golden elder (*aurea*) also, but the last-named should be used with discretion, as it is coarse in growth and not very pleasing in colour.

Sambucus racemosa, from southern Europe, bears handsome corymbs of scarlet fruit. It is hardy in Great Britain, but often disappoints gardeners by refusing to ripen its berries.

Electric Power.—Singularly little use has been made of electricity on the farm. Endeavours have been made at home and abroad to demonstrate its applicability to farm work, but the result has been comparatively insignificant at present. Since electric power has been generally used in other industries, oil engines and disc-wheel windmills have been developed, and have attained considerable popularity, and at the same time have satisfactorily filled the requirements of farmers desiring other motive power than that obtained from horses and steam. Farm work is not concentrated so much as work in factories, and is generally of a nature that allows the use of horses, steam, wind, or internal combustion engines without special difficulties, but giving satisfactory results, so that farmers have not felt any great need of help from electricity. There are, however, many instances where the natural forces—wind and water—might be used to generate electric power to great advantage of the farm, the ease with which the electric current may be carried to work at a distance from the place of generation rendering it possible to utilise streams whose power is running to waste because they lie far from homesteads. It has, however, been demonstrated that it is not merely at the homestead, for stationary work, that electricity can be usefully employed on the farm, for it has been used for propelling ploughs and performing other traction work on the land. Wind power is an available and cheap source of energy, but the want of constancy in winds makes it necessary to provide ample storage for the electricity generated, otherwise the supply could not be relied upon: apart from this, wind, which comes to every spot, is so cheap to harness that it is to be wondered that it is not more frequently used in connection with electricity.

For lighting purposes on the farm, when provided from a cheap source, it is economical and safe, though there is the risk of fusion from short circuiting, which has its dangers in wooden buildings especially where valuable animals or farm produce are kept; but this does not exceed the risk from other lighting materials.

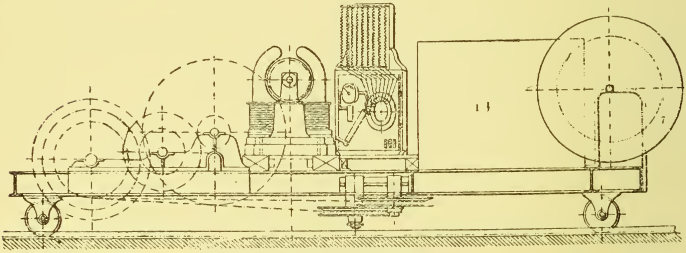
At present electricity is used on the farm chiefly on large estates where the first object is to obtain light for mansions, but where a larger plant than would otherwise be put down is provided to work in the farm buildings and estate yards, advantage being taken of the opportunity to secure the economy of working a bigger plant. Of course, once generated, the power can be applied to machinery of the farm as to the machinery of the factory. Whether in connection with the use of electricity as a motive power on the farm it will be found advantageous to employ electricity for the purpose



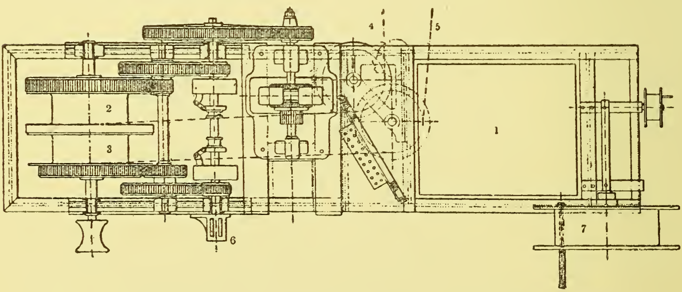
1. Overhead electric wires.
2. Dynamo lead.
3. Winding-gear on waggon-anchor.
4. Hauling-cable.
5. Return-cable.
6, 6. Anchors.
7. Self-adjusting pulley running on cable attached to 6, 6.
8. Intermediate anchor.
9. The plough at work.
10. Ploughed land.

Note.—A, B, and C should be compared together, when the means by which the overhead cable is connected with the electric cable-drum on the waggon-anchor will be seen. The position of the winding-drums and the course of the hauling-cable are also plainly shown; as are also the means for putting the hauling-gear in and out of motion, so that each is made a hauling-in or paying-out cable.

SKETCH A.—Plan showing the position of the Hauling-gear, Plough, and Overhead Electric Wires.



SKETCH B.—Waggon-anchor, with Electric Winding-gear for Implements. Scale, $\frac{1}{30}$. Side view (see Sketch C).



SKETCH C.—Waggon-anchor, with Electric Winding-gear for Implements. Scale, $\frac{1}{30}$. View from above.

1. Motor case.
2. Hauling-drum.
3. Return-drum.
4. Hauling-cable.
5. Return-cable.
6. Gear-shaft.
7. Electric cable-drum.

of electro culture, is a question that will have to be answered in the future; Landström and others have carried out experiments showing that it has a definite effect on plant growth, but how far it will become practicable or profitable has to be shown. At present there does not seem to be much likelihood of its adoption.

In respect to the cultivation of land by electrical agency, a M. Plat, a Frenchman, some years ago established a plant to do his farm and estate work, deriving his power from a turbine in a stream running through the estate. The electricity was generated in the ordinary manner, and was carried to various parts of the farm on overhead cables, the main cable being carried for a long distance on pollard poplars, a long row of which grew conveniently for the purpose; branch cables, however, were carried to desired places on ordinary standards, and all could be tapped when required. Sketch A shows the position of the hauling-gear, plough, and overhead electric wires. The plough in use ploughs only in one direction, provision not being made for a two-way plough, otherwise the roundabout principle of hauling is employed; however, as the return journey is done at a high speed, there is not the loss of time there otherwise would be; it is, of course, only a matter of mechanical contrivance to make a turn-rest or balance plough to do the ordinary up and down work, as in singls sets of steam tackle working on the roundabout principle. Sketch B shows the waggon-anchor, with electric winding-gear for implements, side view; and Sketch C from above.

When the call comes for more general use of electricity on the farm, doubtless the machinery will be perfected, but with the great potentialities of the automobile on the land, and the effectiveness of the light weight, modern oil-driven agricultural motor, there does not seem to be the impetus to the use of the electric motor that might have existed before the agricultural motor was so much developed, as it has done away with the great disadvantage of the excessive weight and expense of the steam traction plough. The electric plough, of course, subjects the headlands to no pressure from the motive power beyond that of the hauling-gear.

Elevators.—Most of the hard manual work in the hay field has been done away with through the introduction of mechanical aids, and the laborious work of pitching the hay on to stacks is removed by the use of elevators; the building of corn stacks in harvest and straw stacks after threshing is done by the same means. The work done is fairly satisfactory, but on the whole the ordinary elevator is not by any means free from faults. The ordinary form of elevator consists of a long trough, 30 feet or so in length, carried on a four-wheel frame, on which is a receiving hopper. Two endless link chains are carried over hexagonal wheels at the top and bottom of the trough, and to these are attached cross-bars in tines placed to seize the load. Suitable means are supplied to raise and lower the trough; and the machine is driven by a horsegear or other power. The chief objections to the elevator are its cost, weight, liability to get out of repair, and its short life, for unless great care is exercised it quickly wears or rots out. American makers make a lighter steel frame elevator, with endless conveyor worked by leather driving belts; and they secure lightness because instead of working at the slow speed of the British, where a heavy load is always in the trough, they shoot it up so rapidly that it never carries a heavy load. British makers require to exercise more ingenuity to improve upon existing forms or develop an entirely new system. For raising hay

and straw the Americans use a wind shoot, but this is not applicable to sheaf work; and it is because the British farmer requires a machine for both loose and bound material that a difficult task is set the engineer; still one cannot believe the elevator, as at present made, is the best that can be provided. The elevator is needed for the higher portions of the stack, yet the receiving hopper is often as low as the raves of the cart from which the load is being emptied; it of course allows the emptier to throw down forkfuls easily, but in ordinary working there is no need for the top of the hopper to be less than 10 feet from the ground; the man can empty into this as fast as an ordinary rick staff will handle it on the stack, and every foot gained implies that a proportionately lighter elevator may be used. The elevator is so necessary at haytime and harvest that farmers are practically obliged to use it even in the present form, which is practically that of the past thirty years; for few important improvements have been made. Standford's of Colchester has avoided most failings, and in theirs, which is made with a telescoping trough and has the horsegear carried on the elevator frame, instead of being a separate machine as is customary, this saves time in setting. The machine is also capable of being driven in connection with a threshing machine. That the trough elevator does not satisfy the farmer's needs is proved by the attention that is given to the clip-fork elevators, which are cheaper, possess good life, and work with good effect on loose material such as hay or straw. There are now many of these on the market, possessing very similar features. A mainmast is guyed vertically upright by ropes; by an arrangement of ropes running over pulley blocks, a grip-fork attached to a rope which passes over a pulley at the outside end of an arm or gaff is made to raise or lower, the raising being effected by a horse attached to the lower end of the hauling rope, which walks away from the pole to the required distance, and returns giving slack to allow the fork to return to the waggon. The fork returns to the waggon with the prongs wide apart, and the man on the waggon places it in position to grip a forkful, the action of hauling causes the prongs to close and grip as much as they will carry, and the hay is then lifted; a considerable quantity is carried up each time, and a load can be speedily emptied.

Hay loading elevators for pitching hay in the field on to waggons will be dealt with under "Hay-making." Chaff elevators, somewhat on the principle of trough elevators described, are used to take chaff as it falls from the knives and empty it into sacks, or, when elongated, into chaff houses. Tube elevators are also used for these purposes, the chaff being forced through them by a strong blast.

Grain elevators are made as cup-elevators, archimædean screw elevators, and forward throw elevators. The cup-elevators consist of an endless belt carrying scoops or cups, travelling over pulleys. The archimædean employs the well-known corkscrew or helical process of Archimedes. The forward-throw elevators consist of a series of troughs containing cross-bars to prevent grain falling back when once it has got over them, the troughs are supported on wooden hangers, and a reciprocating motion is applied; when nearing the end of the throw a jerk is introduced, the grain thrown forward, somewhat in a peristaltic manner, so that it gradually works its way upwards and onwards.

Elm (*Ulmus*) is the only genus of the natural order *Ulmaceæ* indigenous to Europe. Only two species, the wych elm and the English

elm, are certainly identified as native or naturalised in Britain, but there are numerous varieties and intermediate forms, some of which have been distinguished as species according to certain botanists.

"*Trees* with alternate, deciduous leaves, and small flowers in clusters appearing before the leaves on the preceding year's wood. *Perianth* campanulate, with four to six short lobes or teeth and as many stamens. *Ovary* flat, with two short, diverging styles, and divided into two cells, each with a single pendulous ovule. *Fruit* flat, thin, and leaf-like, slightly thickened in the centre, where it contains one pendulous seed" (Bentham).

The Wych Elm (*Ulmus montana*).—A large native tree of spreading habit, the stem and branches forking in a manner which has gained it in some districts the name of the Y tree. This is perhaps the origin of the name "wych," sometimes erroneously written "witch," being the Anglo-Saxon *wice*, from *wican*, to bend or twist; or the meaning may be derived from the pliant, tough bark which used to be twisted into ropes.

"*Leaves*, nearly sessile, broadly ovate, bordered with double teeth, and very unequal or oblique at the base, usually rough on the upper side and downy underneath. *Flowers*, reddish, in dense clusters, surrounded by brownish bracts, which soon fall off; the pedicels scarcely as long as the

Wych Elm.

perianth. *Fruits*, green and leaf-like, broadly ovate or orbicular, six to nine lines long, with a small notch at the top; the seed suspended in a small cavity near the centre of the fruit" (Bentham).

The wych elm is commonly indigenous in Scotland, Ireland, northern and western England, whereof the Celtic name in its various forms, leam (pronounced lam), *leamh* (lav), *leamhan* (lavan), and *sleamh*, *sleamhan* (slav, slavan), has been preserved in such place names as Lomond, Leven, Lennox (shortened from Levenach, the elm wood), Lune in Lancashire, Craigslave and Craigslouan in Galloway, etc.

The wych elm attains a height of 80 or 90 feet, and, when drawn up in close high wood, makes a fine bole of useful timber; but in its early years it requires attention with the knife, on account of its long annual growths and rambling habit. Being a light demander, it is very apt to ruin its neighbours, especially the oak, by overgrowing their tops. Though very capable of resisting occasional violent storms, it does not form a good wind break against constant exposure, especially from the sea, which causes it to assume a warped and stunted habit. The timber is strong, tough, and durable, probably equal in quality to that of English elm, though usually quoted at a slightly lower price. It is principally used for keels of ships and boats, coffins, naves of cart-wheels, piles in wet ground, and

planking. Large burrs or bosses are often formed on the trunk, which produce beautifully marked veneers for cabinet work. The period of commercial ripeness is from eighty to a hundred years.

As an ornamental tree, the wych elm does not take high rank, owing to its straggling growth in youth and the harsh texture of its foliage, which is dull in colour, exhibiting neither the vivid verdure of spring nor the sunset glories of autumn. At a hundred years and upwards, however, it becomes a very picturesque object, with a stalwart trunk and bold limbs, while the smaller branches generally acquire a pendulous habit. It is a bad neighbour to gardens, sending its roots far and wide in search of nutriment. The weeping and fastigiate varieties are decorative trees for isolated and sheltered positions.

In the southern and eastern counties of England the typical wych elm of the north and west is usually replaced by a more upright form, with smooth leaves smaller than those of the other. This has obtained recognition from some botanists as a distinct species under the name *Ulmus glabra*, but, whereas the two forms seem to merge into each other, it is probably no more than a climatic variety, or possibly a hybrid with *Ulmus campestris*.

Neither form of wych elm throws up suckers from the root, by which feature the varieties of this species are most easily distinguished from those of the English elm. When it is desired to propagate the weeping and other varieties of wych elm, it must be done by grafting, but both the northern and southern forms come true from seed, which is borne abundantly on mature trees, ripening about the beginning of June. But for its excessive demand for light, the wych elm would propagate itself naturally as freely as any forest tree, but in most parts of northern and western Britain the undergrowth is too rank to permit many seedlings to survive. Seed must be gathered by hand as soon as ripe, and sown without much delay in drills 15 inches apart, lightly covered with fine soil. In the following spring the seedlings should be lined out 4 inches apart, 20 inches between the rows, and will be fit for planting out at the end of the third season from seed.

The English Elm (*Ulmus campestris*) differs so little botanically from the wych elm that some writers describe them as no more than different races of a single species; but they are easily distinguished from each other by their general appearance and habit. The English elm so seldom produces seed in the United Kingdom that Bentham's definition is not one that can be commonly applied there, namely, that the fruit, which in the wych elm is only slightly notched at the top, in the English elm is deeply notched, the notch almost reaching the seed-bearing cavity. A more conspicuous and quite constant distinction is that the English elm, in all its varieties, suckers freely, whereas the wych elm never does so. Also, the English elm is of far more erect habit than the other, and the leaves, in nearly all varieties except the Chichester elm, much smaller, and of a livelier green in spring, turning to beautiful clear yellow in the fall.

Although commonly known as the English elm, and although it has become more characteristic of the scenery of midland and southern Britain than any other forest tree, *Ulmus campestris* is not a true native, but almost certainly was introduced by the Roman colonists. It has made itself completely at home, and reproduces itself so rapidly by suckers that in some counties, were the land allowed to go back to wilderness, the elm would probably overrun it to the exclusion of all other trees. In favourable situations it grows to an immense height and bulk. Loudon mentions one 150 feet high at Coombe Abbey in Warwickshire, and specimens are not infrequent of 120 to 140 feet in height.

For street planting, the English elm must be used with discretion. In towns of moderate extent, it grows well and forms a very gracious ornament; but it is not patient of smoke, and cannot now be planted in London with any hope of success. The fine elms in Kensington Gardens, Hyde Park, and other places in the metropolis (many of which are the smooth-leaved form of wych elm), attained their present stature before they were closely surrounded with houses, and are rapidly failing, a prey to the boring caterpillar of the goat, the leopard, and the lackey moths, and other insect parasites. The best varieties for street-planting are the Chichester elm and the variety known as the Cornish or Southampton elm, distinguished by its small leaves, graceful sprays, and upright habit.

The timber of English elm is very similar in quality to that of wych elm, and is in request for the same purposes as are described under that species; but it is produced at a faster rate and of a larger size than the wych elm ever attains. To attain perfection, this tree requires a deep, fresh soil, well drained, but with moisture within reach of its far and deep running roots. It is not a tree for mountain planting, neither should it be planted as pure forest, but treated in mixed wood as directed for the Ash (*q.v.*). It will produce good coppice, but not so valuable as that obtained from oak or chestnut. Writers on forestry usually state that the English elm is not suitable for planting in Scotland, but that idea has arisen probably from the fact that

English Elm.'

it has not been much planted there. Certainly measurements recently taken by the present writer of English and wych elms about a hundred to a hundred and ten years old, growing in the same woodland in a southern Scottish county, showed that the English elm had exceeded the other both in height and girth. Moreover, the Cornish variety, above referred to, has proved peculiarly well suited to the humid atmosphere of western Scotland.

There are several forms of the cork-barked variety (*U. campestris suberosa*, *U. campestris major*, etc.), whereof the young wood is garnished and flanged with ridges of cork; but these have nothing particular to recommend them, and, according to Loudon, are short-lived, producing inferior wood.

The qualities of the English elm as a park tree are too well appreciated to require eulogy. The long avenue at Windsor, the Broad Walk in Christchurch Meadows, Oxford, Eton Playing Fields, and the parks of Syon and Osterly in Middlesex, afford a few examples out of many which might be cited of the dignity and luxuriance of this noble tree. It has, however, a dangerous habit of suddenly dropping large limbs during perfectly still weather. This probably results from the leverage of enormous masses of foliage heavily charged with sap, and such limbs as appear likely to yield in this way should be sawn off before mischief occurs.

Seed of the English elm can be obtained from continental sources, and must be sown as soon as possible after being gathered; but this is not a

desirable way of propagating the tree, owing to the great variety occurring among seedlings. Far preferable is the usual mode of propagation in this country, namely, by suckers taken from selected trees. They should be removed in autumn, and may either be placed in the nursery for a year to encourage root formation, or be planted out at once.

Of the six American species of elm, by far the finest, says Mr. Elwes, is *Ulmus americana*, the white elm, a tree of 100 to 120 feet high, producing timber very similar in quality to that of the British elms.

Ensilage.—Ensilage is the process or method by which green fodder is preserved in a more or less air-tight receptacle or building, specially erected for the purpose. The building is called a silo, which in French, Italian, and Spanish means a pit sunk in the ground for the purpose of storing grain, a method which is still in use in many parts of the world. Pliny refers to these as *siri*, while old Greek writers speak of them as *siros*. While the word *silo* is now an adopted English word, the process of making silage was not sufficiently long practised to permit of the derivatives of the word being used in a proper grammatical manner. The preserved material is generally referred to as *silage*, while the verb is made *ensile*, but as often as not, in ordinary language, the word *ensilage* is used, not only as the verb to describe the process, but as the noun to represent the material.

One of the earliest, if not the first, mention we have in English writings of the process, as now understood, is an article in the *Irish Farmers' Journal* of 1839 by John Taylor, in which he describes a process for making brown hay recommended by the Rev. Mr. Klapmeyer of Wormen in Courland. It is next mentioned in 1843 by Professor Johnstone in a paper in the *Highland and Agricultural Society's Transactions*, on the feeding qualities of natural and artificial grasses. His description of the silo and the process of making silage from green grass is almost identical with the method generally followed during the early eighties. In Germany and Hungary it is called "Sauerfutter" (sour fodder), and in the *Farmer* of 1870 there is an article by T. Schwann on the sour fodder process as carried out in Hungary.

It was M. Auguste Goffart, Burtin, Loir-et-Cher, France, who may be said to be the re-orginator of the process about the middle of last century. At first he was not very successful and did not make many converts, but by degrees it was seen that there was some method in his madness, and for ten years, from 1876 to 1886, the process created quite a *furore* in Britain. What materially helped the movement was, that there were one or two very bad seasons for making hay at that time, and it was thought that if the making of silage could take the place of making hay, the farmer would to some extent be independent of the weather. A few years' experience of the making of silage, combined with an improvement in the seasons, convinced the British farmers that silage making on an average of seasons was no improvement on hay making.

The silo may be of almost any shape or size, it may be above ground or under it, or part of both, and it may be built of stone, brick, concrete, or wood, and, if thought fit, the silo can be even done without, and the grass simply built into a stack, very much after the manner of a hay-rick. If a silo is constructed there will be less waste than if the material is put into a silage stack, but in both cases good fodder can be made. The necessary requisites of a silo are that it should be air-tight, and have smooth walls, have the corners rounded, and be not only easily filled but as easily emptied. The building should be provided with a roof, and if high it will

be necessary to have some mechanical arrangement for conveying the material to the top, as it is much more difficult to fork green material to a high level than it is to fork hay.

In Britain the crop principally used for silage purposes is, or was, grass, either natural or artificial, such as would under ordinary circumstances be made into hay. Any succulent crop having a moderate amount of fibre will, however, be suitable, and tares, vetches, green grain, etc., have been successfully used for this purpose. Very succulent materials, like the leaves of cabbages, mangels, turnips, or carrots, are not suitable for making into silage.

In Canada and the States the principal crop used for silage purposes is green maize or Indian corn. Grass or clover need never be cut into short lengths, but should be packed in the silo as they come from the field, and very succulent tares may be treated in the same way, but, if the stems are the least ripened or hardened, the crop should be passed through a straw cutter before being put in the silo. Crops such as green oats, beans, or maize are always cut, and conveyed from the cutter to the silo by some mechanical carrier. In Canadian and States farming, maize silage takes very much the same position that roots do in Britain.

The filling of the silo is generally done in two ways, according to whether it is intended to make sweet or sour silage. If the former the grass should be allowed to wilt a little before it is put into the silo, which should only be filled to the extent of from 3 to 5 feet per day. No attempt need be made to make the material solid as the filling goes on, all that is necessary is that it should be uniformly spread and well tramped round the sides. After the first two or three days' filling, an interval of a day or two should be allowed to elapse in order that the heat may rise by fermentation to 150° F. at least. As soon as this temperature has been reached, filling may begin again and go on slowly until completed. According to the manner and speed with which the filling proceeds, the temperature may rise to 160° F. or over, but the weight of the mass above will shortly afterwards press out the air from among the material, when the temperature will at once begin to fall. After filling has proceeded a certain length, the heating since the previous day will generally have caused such a consolidation of the mass that the whole will have sunk considerably, and the silo will be very little fuller than it was the day before. When the building is full, the material should be surface loaded with dead weights or pressed mechanically. Silage so made, will be made brown and have a sweet smell.

If the filling has proceeded rapidly, the temperature may not rise to over 120° F. or 130° F., in which case the silage will come out green in colour but sour in smell, which in some cases is rather loathsome, especially to persons unaccustomed to it. Stock, however, eat the one as readily as the other, and seem to thrive alike on both. The theory of the difference of the two kinds of silage is that where the mass does not reach to a higher temperature than 120° F. the bacteria which form acetic acid attack the starch of the silage and convert it into acid. If the silage is allowed to ferment and the heat to rise to 150° F. or over, the acid-forming bacteria are killed, and a portion of the starch is converted into sugar. The heat generated during fermentation is the result of the combustion of a certain amount of the starch in the crop, which to this extent is lost. All silage, no matter how well made, never contains the same amount of food ingredients that the crop did from which it was made. The same to some extent applies to hay made from any kind of crop, but

in hay-making under normal conditions the loss is less than with silage. Strong-smelling silage, after removal from the silo should not be stored in the vicinity of the cows, or be carried about in the hands by persons who are to be engaged in milking the cows. If either is done, it is almost certain that the smell of the silage will be conveyed to the milk. Under no circumstances is the smell of sour silage pleasant, but in milk it is most disagreeable.

Entail.—Where the class of heirs upon which an inheritance can devolve is limited to heirs begotten of the ancestor's body, the estate is called an estate in *fee tail* or *estate tail.* Such estates may be granted between living persons, or by will.

Tenants in tail (such is the term applied to the owner of an estate tail) have nearly as large powers of alienation as tenants in fee-simple (practically unfettered owners). These powers are of recent origin.

Estates tail are either *tail general* or *tail special.* In the first case the limitation is to " A. and the heirs of his body," and in the second to " A. and the heirs of his body *by B.*" There is also a subdivision dependent on the sex (if any be specified) of the issue, *e.g.*, to " A. and the heirs-male of his body " is a *tail male*; to " A. and the heirs-female of his body " is a *tail female.*

If there has been no alienation of the estate tail upon failure of the issue specified (as above mentioned) by gift or by will, the estate reverts to—(1) the grantor, (2) his representatives, or (3) any person the estate may have been limited to on failure of the specified issue. Estates tail may be got rid of by the process of " barring," the object being to convert them into fee-simple estates with which the owner can deal as he likes.

In ancient days a tenant in tail converted his interest into more absolute ownership by a system of complicated legal processes known as fines and recoveries by which sham parties in sham actions defeated the rights of future heirs. By the Fines and Recoveries Act, 1833, this procedure was all done away with, and there was substituted therefor a simple deed, to be executed by the tenant in tail and enrolled in the Central Office of the Supreme Court of Justice (within six calendar months after the execution). By such a deed a tenant in tail in possession can dispose of the lands entailed for an estate in fee-simple, thus defeating, at the same time, the claims of his issue and of all persons having any estate in remainder or reversion.

The exercise of the above right is subject to certain restrictions, as will be pointed out hereafter.

In many parts of the country a common idea prevails that an estate descends from life owner to heir as of right, but this is, of course, incorrect. In the first instance no estate can be tied up in perpetuity, and the limit to which settlors can reach is the unborn issue of living persons. Usually in families where the custom of primogeniture is kept up a settlement takes place on marriage, the property being given for life to the husband, the eldest son, subject to jointures and portions, becoming tenant in tail, and after him, his brothers in order of seniority. When the eldest son comes of age, a resettlement takes place, the entail having been barred, and remainders and reversions got rid of.

Whenever an estate tail is not in possession, but has before it a life interest enjoyable by some other person before the tenant in tail can come into enjoyment, the power of the latter to acquire an estate in fee-simple (in remainder) expectant on the death of the life tenant is subject to certain limitations. Under the old law the consent of the life tenant was required

for altering the tenancy. This consent to-day is practically required still, the Act of 1833 having erected what is called a protector of the settlement, without whose consent (signified by the same deed which bars the entail, or by a separate deed to be executed on or before the day of the execution of the former, and to be enrolled in the Central Office of the Supreme Court of Justice at, or previous to, the enrolment of the deed barring the entail) the remainders and reversion cannot be barred. Usually the "protector" is the first tenant for life under the settlement, following the old law, but there is power given by the Act for any person entailing lands to appoint instead any number of persons not exceeding three to be "protector of the settlement" during the continuance of the preceding estates. The protector (as to his consent) is under no restraint; he may use his own discretion absolutely. If he refuses consent the tenant in tail may still execute a deed, and enrol it, thus barring his own issue, but the estates in remainder and reversion are not affected.

An estate tail cannot be barred by any person who is tenant in tail after possibility of issue extinct. This only happens where there is an estate tail *special*, *e.g.*, to "A. and the heirs of his body by his wife B.," on the death of B. without issue. A.'s possibility of issue within the meaning of the estate is extinct. But this can never happen in the case of an estate tail general because the law presumes that so long as a man is alive he is capable of begetting children.

An estate tail can only be barred by an actual conveyance by deed duly enrolled, and not by will or contract not completed in life.

A tenant in tail has certain powers of alienation which can take effect without barring the entail. Any disposition of his lands holds good during his life. He can mortgage or sell his life interest. By the Settled Land Act, 1882, he may grant certain leases allowed by the Act, and may sell or exchange the land without the necessity of barring the entail, but the money or lands so derived must of course be settled as was the settled land.

As to free enjoyment, a tenant in tail is practically on an equal footing with a tenant in fee-simple. He may cut down timber for his own benefit and commit what waste he pleases (*see* Waste).

Authorities.—Williams on *Real Property*; Challis on *Real Property.*

Enteritis.—*Enteritis* is the technical term applied to inflammation of all kinds and degrees affecting the bowels. When inflammation is limited to the inner surface or mucous membrane, it is spoken of as "muco- or catarrhal enteritis." When the whole thickness of the bowel is inflamed the condition is often termed "enteritis proper," "deep-seated" or "phlegmonous enteritis." Indeed, "enteritis" is regarded by many as referable only to the last-named condition.

Inflammation of the bowels may be due to a great variety of causes, which may gain access to the intestines by way of the mouth by eating or drinking, or they may be carried there by the blood. The most common causes of enteritis in the domesticated animals are worms or micro-organisms—bacteria—while occasionally poisons are responsible. Many worms have their natural residence in the intestines of horses, cattle, sheep, and pigs; some of them are capable of seriously injuring the lining membrane, and when in large numbers of inducing inflammation called parasitic enteritis. The intestines always contain myriads of bacteria, but only special ones can get into the wall of the bowel to do harm, unless the wall is injured; such an injury worms may effect. There are certain

bacteria, as those of tuberculosis, cattle plague, white scour, and swine fever, which possess the power of producing enteritis in what is usually regarded as the sound bowel. Irritant poisons, such as arsenic, mercury, and common salt, used in farm operations of dipping, wheat-dressing, pig-feeding, and castor-oil beans, etc., with cakes and prepared foods, or given as medicine in poisonous doses, and some mechanical irritants as glass, grit, etc., also taken with the food, damaging the walls of the bowel by virtue of their sharpness or roughness, must be included amongst the causes of enteritis.

Inflammation of the inner lining membrane, muco-enteritis, is often due to the action of some irritant which may be found on its free surface. The principal symptom of this condition is diarrhœa, and the consequent weakness and wasting. Often there is no other general disturbance except a slight rise of temperature, which, however, is not always existent. It is frequently a serious condition, particularly in young animals, as the cause is often persistent and not easily removed by medicinal treatment. The animal may become exhausted by the drain on its system, or inflammation may extend deeper into the wall of the bowel, with rapidly fatal results. The treatment will depend on the cause. If this be worms, attempts may be made to dislodge them by giving vermifuge medicine. If due to bacteria, drugs credited with antiseptic or disinfectant action may be given. Such cases, however, require expert advice. Under all circumstances affected animals must be sheltered from cold, indeed artificial warmth is often called for, and only easily digestible and nutritious food given.

Inflammation of the deeper parts of the wall of the bowel, though occasionally due to poisons, etc., is usually caused by bacteria which enter through the injured mucous membrane, or are brought by the blood stream from another part of the body.

This form of enteritis is marked by symptoms of a very different kind. The signs of pain are marked, and the temperature is high. There is great depression. Sometimes constipation exists, at other times diarrhœa. The pulse is more frequent, the breathing more or less hurried, and the animal wears an anxious expression. These symptoms are constant, that is to say, they do not come on or pass off to return again, as in colic, while the evidence of pain is not usually so marked. This condition runs a comparatively short course in the domesticated animals. The result is often fatal, though not invariably so.

The treatment of deep-seated inflammation of the bowel demands great care and skill. Each case must be treated on its own merits. If poison be suspected, the proper antidote must be administered. In all cases it is necessary to relieve the pain, for which purpose opium or chlorodyne, etc., is given by the mouth, morphia, etc., injected under the skin, warm water applied to the abdomen by packs, the skin generally kept warm. Every possible comfort should be provided. Purgative medicines often intensify the symptoms and hasten death. Indeed, it is thought by some that large over-doses of purging drugs may sometimes bring on the disease, yet it may be necessary in some cases to use artificial means as enemas to relieve the bowels. Those forms of enteritis regarded as "specific" will be described under the special heading of the diseases of which enteritis is a prominent feature.

Entomology.—Entomology is the study of insects. With regard to their relation to man, insects may be divided into the beneficial and the

harmful. Under the heading beneficial, we would include the few that are used as food by man, *e.g.*, locusts; the insects that serve as food for fishes and for birds; the insects which play an important part in the pollination of flowers, and without whose agency seed would not be produced; the insects whose products are directly useful, *e.g.*, honey bee and silkworm; the insects which play the part of scavengers, burying and devouring putrefying organic matter that might otherwise cause disease; the parasitic and predaceous insects which prey upon insects that might destroy crops. As harmful insects we would include those which cause loss to man either by spreading disease to man himself or to stock; and such as destroy his crops and stored products. There are numerous European records of immense loss to crops the result of insect attack, while in America—both Canada and the United States—the great losses due to insects have resulted in the formation, in Economic Entomology, of State Departments whose yearly work is enormous. Recently Professor Slingerland of Cornell University, referring to the United States, wrote: "The yearly losses from insect ravages aggregate nearly twice as much as it costs to maintain our army and navy; more than twice the loss by fire; twice the capital invested in manufacturing agricultural implements; and nearly three times the estimated value of all the fruit orchards, vineyards, and small fruit farms in the county."

Position of Insects in Animal World.—The Class Insecta is the largest Class of the division Arthropoda or jointed-footed animals. The Arthropods are divided into four Classes, which may be distinguished as follows:—

(1) Crustacea, *e.g.*, crab, lobster, shrimp, and slaters (or woodlice). The head and thorax are joined into one piece, the cephalothorax; two pairs of antennæ; numerous appendages showing modifications for biting, fighting, walking, swimming, etc. They are nearly all water forms, breathing by gills, but the woodlice are well-known land forms, some being destructive to plants.

(2) Myriapoda, *e.g.*, centipedes and millipedes. The head is followed by many resembling joints nearly all of which bear one or two pairs of appendages; there is one pair of antennæ; breathing is by means of tracheæ.

(3) Arachnoidea, *e.g.*, spiders, ticks, and mites. The head and thorax are joined together, and are followed by the abdomen; the adult has eight legs; no antennæ are present; respiration is by tracheæ or by lung-books.

(4) Insecta. Here the body is divided into three parts—head, thorax, abdomen; there are three pairs of legs in the adult, the legs being borne by the thorax; respiration is by tracheæ; most are winged, and they are the only winged Arthropods.

The head of the insect carries the mouth parts, the antennæ, the eyes. The thorax is divided into a fore or prothorax, middle or mesothorax, and a hind thorax or metathorax. The mesothorax and the metathorax usually bear each a pair of wings. If there be only two wings, they are borne by the mesothorax. The six legs are also borne by the thorax, a pair from each of the regions mentioned. Each leg consists of the following parts: a coxa jointing the leg to the thorax, a small trochanter, a femur generally strong, a tibia often with spines, and a variously jointed tarsus ending in claws. The number of joints in the tarsus is often made use of in Classification. The abdomen of the insect seldom bears external appendages, but it sometimes does, *e.g.*, the projecting styles of the cockroach and the forceps of the earwig.

The mouth parts consist of an upper lip or labium, a pair of mandibles unjointed, a first pair of maxillæ, and a second pair of maxillæ, which fuse to form the labium or lower lip.

The mandibles in a biting insect like a beetle or a cockroach are strong and unjointed; the first pair of maxillæ are made up of several pieces, and in a biting insect are partly masticatory and partly exploring in function; the second pair of maxillæ resemble in general the first pair, but their basal parts are fused. These mouth parts show much modification in various insects, *e.g.*, the mandibles may be modified as piercers as in plant lice and gadflies, or they may be rudimentary or wanting as in moths; the first pair of maxillæ may be modified to form a sucking tube as in butterflies and moths, or they may be piercing organs as in aphides; the second pair of maxillæ also show much modification.

Insects with biting mouth parts are classified together as Mandibulata, while those that have sucking mouth parts are grouped as Haustellata. Some insects, like the bees, can both bite and suck. In dealing with harmful insects by means of insecticides, it is important to know whether the insects to be treated have jaws and masticate their food, or whether they take fluid nourishment, for the spray material used will be different.

Alimentary canal.—The alimentary canal forms a long tube more or less coiled in different insects. There is considerable variation in size and shape of parts according to the food habits of the insect and whether the food taken be solid or liquid. The essential structures, however, are much the same. A mouth leads by a pharynx into the œsophagus or gullet. Salivary glands pour their secretion into the gullet, the secretion aiding in digestion. The œsophagus running backwards through the thorax passes into the crop, where food material may be stored and where digestion takes place. The crop is followed by the gizzard, which, in such an insect as the cockroach, is well marked, with thick walls and a horny lining produced into teeth. The gizzard is masticatory, and also acts as a strainer. In an insect that feeds on liquid food material the gizzard is much reduced. From the gizzard the food material passes to the stomach, through the walls of which nutritive material diffuses. Into the front end of the stomach cæca or blind tubes empty their secretion as an aid to digestion; this secretion passes up through the gizzard. At the hind end of the stomach are numerous very delicate tubules, the Malpighian or urinary tubules, excretory in function. The stomach leads into the intestine; whence waste passes to the outside by an opening.

Circulatory systems.—There is no closed system of veins and arteries in an insect for the blood to circulate in. Just under the back is a tube divided up into chambers. This is the heart. Into it blood from the body passes by a series of inlets, which during the heart beat or contraction are closed by valves. When the heart contracts, the blood is forced forwards and passes out, by the so-called aorta, into the body cavity, bathing the various organs; receiving from the alimentary canal food material; receiving from the air-tubes oxygen, and parting with waste gaseous material; waste material is also extracted by the Malpighian tubules; head and legs and wings are all supplied, and finally the blood passes again into the heart.

Respiration.—Air is not taken by the insect through the mouth, but through openings in various parts of the body. These openings are called spiracles or stigmata. They may have valves which open and close the spiracles, and the spiracles may also be protected by fringes against the

entry of dust and foreign particles. These spiracles lead into tracheal tubes or tracheæ. These tracheæ—a system of tubes and tubules—branch all over the body and to every organ and part of it, and conduct the air which passes partly by diffusion and partly by the muscular contractions of the insect. The tubes and tubules do not collapse, but are kept open by strengthening rings or spirals of horny chitin. In actively flying insects air sacs are in association with the tracheæ. Certain insecticides have for their purpose the choking up of the spiracles so as to suffocate the insect, whilst others penetrate the body through the spiracles.

Nervous System and Sense organs.—On the upper surface of the gullet at the head end are collections of nerve matter or ganglia forming the brain. From this brain a nerve ring passes round the gullet, on the under side of which is another large nerve centre from which a double nerve-chord runs back along the under surface; this nerve-chord has in every segment of the body two ganglia. Nerves pass from the various ganglia to supply the different organs and regions of the body.

Sight.—Most insects have two kinds of eyes, simple and compound. The simple eyes or ocelli—often three in number, but sometimes two or one—are generally on the top of the head. These simple eyes may see as our eyes do, but are "confined to the perception of very near objects," and may be useful in dark places.

The compound eyes are two in number, one on each side of the head. The compound eye, with its facets or lenses varying in number from less than twenty in some insects, to thousands in others, may be looked upon as a collection of simple eyes; but each facet or lens does not take in an entire optical image. As a child makes a picture by piecing together a number of bricks each containing a portion of the picture, so the compound eye builds up an optical image after the fashion of a mosaic. In spite of the two kinds of eye, insects are probably short-sighted, the chief use of the eyes being the perception of movement and light sensations, and not of form.

Smell.—This sense is highly developed in insects. The sense of smell is resident to a great extent in the antennæ. Numerous smelling pits in these are in association with nerve cells and nerve fibrils which convey impressions to the nerve centres. Food is found very readily by sense of smell, and by means of smell the sexes may find one another.

Touch.—Sensory hairs are present on the antennæ, which markedly are exploring organs; numerous tactile hairs are also present on different parts of the body.

Taste.—Insects can by a sense of taste discriminate between foods. Processes and pits connected with taste are to be found on upper and lower lip and in other regions of the mouth, these containing nerve endings.

Hearing.—The fact that many insects sing or give out noises that may be interpreted as song, presupposes hearing on the part of others. In many insects the hearing organ—typically a tense membrane with a cavity below and in association with nerves and nerve fibrils by means of little processes or pegs—cannot be located, but in midges and gnats such "ears" have been found on the second joint of the antennæ; the grass-hopper shows them on each side of the first segment of the abdomen, while in the cricket the "ears" are on the front tibiæ.

Round of life.—Insects are male and female. In their life-history there is a metamorphosis, a series of changes abrupt or gradual, by which the insect passes from the egg to the adult condition. A butterfly, for

example, has four stages in its life-history, known as imago or adult, egg, larva, pupa; the larva is a sixteen-legged form that can move about actively in search of food; the larva grows rapidly, and on being full fed passes into a quiescent or resting stage known as the chrysalis or pupal stage, in which no food is taken. Maturing and development of parts take place during the resting stage, and ultimately the adult insect appears. Insects which show all these four stages in their life-history are said to have a complete metamorphosis or to be Holometabolous.

Some insects have not all four stages present in their life cycle, and such are said to have an incomplete metamorphosis and to be Hemimetabolous or even Ametabolous.

A grasshopper or an earwig, for example, lays an egg from which there hatches a tiny form not unlike the parent, but smaller of course, and without wings and not sexually mature. This young individual feeds and grows and moults and ultimately without any abrupt changes of form moults itself into the winged adult, without there having been any quiescent stage.

In insects which have a complete metamorphosis the form of the larva differs, and to the different forms different names are given: thus if the larva have numerous legs and can move about actively, it is known as a caterpillar; if the legs number only six, the larva may be called a grub; whilst larvæ that are legless are known as maggots.

Similarly there are various forms of pupæ. The pupa of a butterfly on account of the hardening of the outer skin has the wings and the legs immovably fixed to the sides of the body. Such a pupa is known as an obtect pupa. In the pupa of a beetle, on the other hand, the antennæ and the legs and the wings are free, though they may be more or less closely pressed against the body. Such a pupa is known as a free pupa. The pupæ of some Holometabolous insects can move freely, *e.g.*, the pupæ of the caddis fly and the mosquito.

The pupa may be naked or may be inclosed and protected by a cocoon of silk or other material. Among flies the pupa lies protected by the last moulted skin of the larva, which skin dries and hardens.

There is much variation according to the species and to external conditions in the length of life in the various stages as egg, larva, pupa, adult. The eggs of a housefly hatch in twenty-four hours, while those of the nun-moth laid in July of one year do not hatch till the next April. The onion-fly maggot may be full grown in a fortnight, while the grub of the wireworm may live as grub till the third or fourth year. The pupal stage of a hover-fly may last only a few days, that of the death's-head moth in certain circumstances a year and more. The mayfly as adult may live only a few hours, a butterfly for a fortnight, the pine weevil for three years, and the queen bee for six or seven years. Food and weather conditions, and specially the winter season, cause great variations in length of life even in the same species.

The importance of a knowledge of the life-history of a harmful insect is manifest, for only then can treatment be rational. An insect may be vulnerable and open to treatment in all of its stages of development, but it is very often the case that in one special stage it can be best attacked, and in many species in one stage only, and it may even be in one part of that stage.

Classification of Insects.—It is not easy to give a classification of insects that would show relationship, but the Orders of insects—to be named below—that contain insects of importance in agriculture may be

described fairly as Natural Orders. For our purpose we may divide insects into the following groups:—

Coleoptera or sheath-winged insects,
Diptera or two-winged insects,
Lepidoptera or scale-winged insects,
Trichoptera or hairy-winged insects,
Neuroptera[1] or nerve-winged insects,
Hymenoptera or membrane-winged insects,
Thysanoptera or fringe-winged insects,
Orthoptera or straight-winged insects,
Thysanura, the bristle tails,
Collembola, the spring tails.

Certain of these orders may be contrasted thus:

Order.	Metamorphosis.	Mouth Parts.
Coleoptera	Complete	Biting
Diptera	,,	Sucking
Lepidoptera	,,	,,
Hymenoptera	,,	Bite, and may suck
Hemiptera	Incomplete	Sucking
Thysanoptera	May be complete	Pierce and suck
Orthoptera	Incomplete	Biting

Characters of the Orders.—**Coleoptera,** or Beetles.—The metamorphosis is complete; the mouth parts are mandibulate. The wings are four in number; the front pair are horny, being known as elytra and functioning as sheaths or wing covers to the hind pair of membranous flying wings. When the elytra are closed they meet in a straight fold down the back. The larva is typically a grub, with three pairs of thoracic legs, able to move about and with strong biting jaws; the grubs of weevils are legless. The Order contains many species harmful in agriculture, and harmful both as adults and as larvæ. Some species are useful as preying on other insects, *e.g.* the tiger-beetle and the lady-bird, or acting as scavengers, *e.g.* the burying beetles. The ground beetles (Carabidæ) are as a family carnivorous and useful, but some species are destructive to strawberries and to mangolds.

Classification of Beetles.

A. Section Pentamera, *i.e.* beetles with five joints to the tarsus; *e.g.*, tiger beetle and ground beetles.
B. Section Heteromera, *i.e.* the front two pairs of legs have five joints to the tarsus, the hind legs with only four joints to the tarsus; *e.g.*, the blister and oil beetles.
C. Section Tetramera, *i.e.* the tarsi are seemingly four-jointed, but there is really a small additional joint at the base of the fourth; *e.g.*, weevils, asparagus beetle, turnip "fly," long-horned beetles.
D. Section Trimera, *i.e.* tarsi seemingly three-jointed (the third joint, however, consists of two joints); *e.g.*, the ladybirds.

[1] The term Neuroptera is used here in its widest sense, embracing antlions, dragonflies, mayflies, stoneflies.

Diptera, or True Flies.—The metamorphosis is complete; the mouth parts are fitted for a liquid diet. There are two wings borne by the large middle segment of the thorax. The hind wings are reduced to processes called halteres or balancers or poisers; exceptionally, the sheep ked is wingless. The larva is typically a maggot without legs. Pupation takes place under cover of the last moulted skin of the maggot, but in the fungus-gnats the pupa is naked. The habit of life as adult or as larva is very varied. In some species the mouth parts of the adult are modified as lancets, by which the skin of an animal can be pierced and then the blood drawn up, *e.g.*, the cleg and the mosquito; others with a soft proboscis take the juices of flowers. The maggots of many flies are very injurious to plants, *e.g.*, the daddy-long-legs, the onion fly, the carrot fly, the frit fly; the maggots of others are injurious to stock, *e.g.*, those of the bot flies and the green bottle fly; some, like the blue bottles, are scavengers. Nor are useful predaceous species wanting. Adults of the family Asilidæ capture on the wing other insects, impaling them on their rostrum. The Tachinidæ are parasitic on other insects which are destroyed by the Tachinia larva; the larvæ of the Hover flies devour aphides. The Aphaniptera, or Fleas, wingless but long legged, may be looked on as an outlying section of Diptera.

Classification of Diptera.

A. Suborder Orthorrapha—flies which escape through a T-shaped opening in the larval skin; the pupæ are mummylike.
  1. Section Nematocera, or long-horned flies; the antennæ are many-jointed and generally long; *e.g.*, gall midges, midges, gnats, craneflies.
  2. Section Brachycera, or short-horned flies; the antennæ are short, three-jointed; *e.g.*, Tabanidæ, or gadflies.

B. Suborder Cyclorrapha—flies which issue through a round opening; pupæ barrel-shaped; *e.g.*, hover flies, bot flies, tachinia flies, flesh flies, house fly, blue- and green-bottles, stable fly, carrot fly, onion fly, cabbage root fly.

Lepidoptera. The Butterflies and the Moths.—The metamorphosis is complete; the mouth parts of the adult are fitted for a liquid diet. The wings are four, the front ones rather larger than the hind ones; all four wings are used in flight, and are covered with scales, which are modified hairs. The larva is a caterpillar with typically sixteen legs; the three pairs on the three segments nearest the head—thoracic legs—are transversely jointed and end in a curved spine; the legs borne by segments behind the thorax, including the anal claspers, are unjointed and end in a circlet of hooks; they are called abdominal prolegs. Caterpillars of the family Geometridæ have only ten or twelve legs, and are known as loopers or spanners. The pupa is an obtect pupa and is characteristically enclosed in a cocoon.

The butterflies and moths are nearly all plant-eaters in the larval stage, and some of them can be extremely destructive, *e.g.*, the cabbage white caterpillar, the diamond back moth, surface caterpillars, etc. Some of the worst enemies of fruit trees are moth larvæ, *e.g.*, the winter moth, the magpie moth, and the codlin moth.

The order Lepidoptera is divided into the Rhopalocera, or Day-fliers (the Butterflies), and Heterocera, or Night-fliers (the Moths). Between these two there is no one set of characters which will serve as an absolute distinction, but generally they may be distinguished as follows:—

Butterflies.	Moths.
Diurnal.	Fly by twilight or night.
Antennæ end in knobs or clubs.	Antennæ not knobbed.
Fore and hind wings not joined by a bristle.	Fore and hind wings often joined by a bristle.
When at rest, the wings are held erect, back to back.	When at rest, the wings are held sloping or roof-like over the body, or are spread horizontally.

Hymenoptera. Bees, Wasps, Ants, Sawflies, and Ichneumon Flies.—The metamorphosis is complete; mandibles are present, and there may also be a sucking proboscis. The wings number four, and are clear and membranous; the front pair are larger than the hind pair; the hind edges of the forewings have a ridge or fold which, when the wings are stretched in flight, catches into a row of recurved bristles or hooks on the front edge of the hind wings.

The larva may be a legless one living on stored food, *e.g.*, larva of bee, or in a gall, *e.g.*, the oak gallfly; or it may be a six-legged grub feeding externally, *e.g.*, the social pear-sawfly, or a six-legged grub—the legs not well developed—living in the wood of trees, *e.g.*, woodwasp, or a caterpillar with more legs than sixteen, *e.g.*, pear and cherry sawfly. There is much variation in mode of life. The larvæ of some of the sawflies can be very harmful, *e.g.*, corn sawfly, gooseberry and currant sawfly, turnip sawfly; the larvæ of the Ichneumonidæ are parasitic in insects of various Orders, including their own. The round of life of the hive bee and other social Hymenoptera like wasps and ants is full of interest. Wasps, however, in a "wasp year" may prove very troublesome, and ants may, in gardens, also cause much annoyance.

The Hymenoptera may be classified as follows:

I. Suborder Phytophaga, or plant-eaters.
- *a.* Family Cephidæ, the Stem Sawflies. The larvæ live in shoots; *e.g.*, corn sawfly.
- *b.* Family Tenthredinidæ, or Sawflies. The females have an ovipositor in the shape of a sawing apparatus; the larvæ have more than sixteen legs, and they feed externally as a rule.
- *c.* Family Siricidæ, or Wood Wasps. The ovipositor of the female is modified as a borer; the larvæ have six small legs, and feed in the wood of trees.

II. Suborder Petiolata, so called because of a deep constriction between the thorax and the abdomen.
- *A.* Series Parasitica or Terebrantia. The ovipositor is not used as a sting; *e.g.*:
  - *a.* Family Cynipidæ, or Gall Flies.
  - *b.* Family Ichneumonidæ
  - *c.* Family Chalcididæ
  - *d.* Family Braconidæ

  } Larvæ parasitic on other insects.
- *B.* Series Aculeata. The ovipositor is modified in the females as a sting; *e.g.*, bee, wasp, ant.

Hemiptera.—The metamorphosis is incomplete; the mouth parts are modified as piercing bristles and for sucking. The wings are nearly always four—the males of the scale insects have only two—but wings may be

absent. The name Hemiptera is given from the fact that the forewings may differ in texture, a part of the wing being membranous and a part horny; the front pair of wings may differ in texture from the hind pair.

There are three sub-orders, the Homoptera, the Heteroptera, and the Parasitica.

Homoptera.—The wings are of the same texture throughout and usually held sloping or roof-like over the back; the head is joined to the prothorax so closely that the coxæ of the forelegs touch the sides of the head. The beak or proboscis arises from the hind part of the under side of the head, *e.g.*, aphides, scale insects, and jumping lice (Psyllidæ).

Heteroptera.—Forewings with the basal half tough and thickened but the apex of the wing membranous; when at rest the four wings lie flat on the back with the membranous tips overlapping; the head is somewhat separated from the thorax; the beak projects from the front part of the head, *e.g.*, bugs, some of them harmful to plants, others predaceous on insects.

Parasitica.—Wingless with unsegmented sucking beak, *e.g.*, the sucking lice.

Thysanoptera.—As regards metamorphosis the insects of this order form a connecting link between a true complete metamorphosis and the absence of a resting stage. In the case of thrips, for example, there hatches from the egg a young form which feeds for a varying length of time. Then follows a non-feeding stage when the full-grown larva or nymph—as it is sometimes called—is sluggish. The wing rudiments are enveloped in a sheath, while a film surrounds the legs. In this stage the insect may be quite passive. This is succeeded by the mature winged forms. The mouth parts are fitted for a sucking diet, the food material being pricked by piercing styles—the modified mandibles and maxillæ. The wings are four in number, and have long fringes and few veins; the front pair are somewhat larger than the hind wings. The feet are interesting, as there is at the tip of each tarsus a small expansible bladder or sucker. The eggs are laid on leaf and on bark, and the insects do harm by puncturing the tissues and draining away the sap.

Equipment of the Farm comes under two heads, that provided by the landlord, and that provided by the tenant. The landlord's is the more permanent, the tenant's the transitory. The landlord in Great Britain usually provides the farmhouse, farm buildings, cottages, necessary bridges over watercourses, and other things not readily removed, and likely to be required so long as the farm is kept to its purpose. The tenant provides the machinery and the means of working the farm; but it is not certain that a new tenant will follow the same systems of management as his predecessor, consequently what suited his predecessors may not be altogether applicable to his needs. Whilst land was let under strict rotation there could not be great deviation in the methods of working the farm; but since freedom of cropping has become general, the landlord is placed in a somewhat perplexing position, as he may find that after having equipped the farm for dairying, the new tenant gives up dairying and goes into sheep-farming; or the position may be reversed; possibly market-gardening takes the place of cattle-raising, and so on. Thus after the expenditure of a large sum he may find the buildings unoccupied, or not properly applicable to the requirements of the farm. In these days of low rents and heavy death dues, and with prospect of having to provide a number of small homesteads and houses, and subdivide the land into small

holdings, the landlord has to exercise great caution in the outlay should he desire to see a profitable return from his estate. Fortunately for the farmer during the time of greater agricultural prosperity substantial houses and homesteads were commonly erected on farms, and he benefits thereby. What buildings the landlord does put up should be such that they may be readily converted from one purpose to another, as the different views of succeeding tenants demand. It is scarcely likely that landlords will build as substantially in the future as in the past, as the investment cannot be regarded as being so safe. In good agricultural districts in England freehold farms have been sold within the past twenty years for less than the cost of the buildings on them; the buildings at the time being in a good state of repair. However, local authorities are being invested with powers which do not leave the matter entirely in the landlord's hands, especially in respect to buildings on dairy farms.

Sufficient cottages to supply adequate labourers within reasonable reach of their work are a necessity; it is of great convenience for these to be attached to farms, but in England country labourers very largely dwell in villages supplying housing apart from the holdings themselves, so there is not quite the same need for houses on the farm as there are in districts where village communities more rarely exist. That housing should be good and the surroundings attractive is agreed upon by all, as they are main factors in keeping trained farm labourers from leaving the land; the loss of even one well-trained, skilled farm labourer is a misfortune to a parish, for it takes longer for a man to become an all-round farm artisan than it does to train one to be a soldier; and he is not replaced when another man, no matter how strong, but without specific training, follows him. In spite of this the number of labourers on the land is likely to decrease as machinery further develops. The threshing machine made its influence felt more than half a century ago, the binder came more than a quarter of a century since, and now haymaking machinery is being developed which still further reduces the need for hands in the hay field. Labour-saving machines are affecting every branch of farming, and fewer hands are required on the land year by year. The experience of British farmers for generations has been one where labour was always in abundance, and British farming and management was built up round this situation, with the result that wherever manual labour could be employed it was used. In newer countries the reverse has been the case, and machinery has been used wherever possible. This has been reflected upon the habits and prejudices of farmers, and British farmers showed a slowness in taking advantage of mechanical aids; however, within the present and past decade there has been a great change, the intensity of which was emphasised by the short supply of labour at the time of the South African war. From this period dates an activity in acquiring better machines which is likely to have its influence on British farming for a long time to come; it is now recognised that foreign competitors must be met with their own weapons. So far as farm labourers' cottages are concerned, it is certain there will be fewer labourers needing them; and though doubtless there are estates and districts where these are insufficient, they are not so numerous as has often been stated. The chief object in the future will be to make the homes more attractive, so as to keep the better class of men from leaving the land. The advantage of a sufficiency of land to meet the man's individual requirements is well known, and can generally be supplied; and it is well that it should be.

The planting of fences is generally done by landlords, and they are maintained by the tenant, although occasionally, as on the Duke of Bedford's

estates, the landlord sees to their maintenance. The new Act throws more responsibility on the tenant than has been exercised hitherto, and the necessary part of the equipment of the farm will probably be better regarded than in the past. Still there are districts, in fact almost counties, where there is a very unnecessary number of hedges, which are thus a wasteful adjunct to the estate and farm, occupying land which could be more usefully employed, and involving an undue cost in their preservation. Land drainage is primarily a landlord's charge, though much has been done by farmers in some districts. Neglect on the part of tenants to keep open the mouths of drains, and to keep clean ditches, nullifies much of the value of drains, and necessitates redraining where it ought not to be required. After a prolonged dry period, such as the past twenty years has been, drains get into a bad condition; consequently, when rainfall of exceptional persistency arrives, the land becomes water-logged. Much of the bad effect of the heavy rainfall at the end of the "seventies" and the early "eighties" was due to this neglect. The proper drainage of land is the first operation to equip it to carry good crops and sound stock, and this cannot be insured when the outlets are neglected. It is important to landlord and tenant alike.

The tenant's share in the equipment of the farm is that which affects its working in accordance with the system of farming he intends to adopt. It is an unfortunate fact that the majority take more land than they can properly equip, the ill-effects of which present themselves in many ways. Extravagant farming is bad farming; but farming with insufficient capital places the farmer in an unsound business position, so that he cannot work to the best advantage, no matter how good a farmer he may be, or how shrewd a business man he would otherwise show himself to be. There is no doubt that a large proportion of the land is farmed with from a quarter to a half less capital than could be profitably employed upon it: this implies that it is not stocked so fully as it should be, it suffers for want of manure, the machinery equipment is inefficient, and the farmer has to take credit, and pay for it dearly, with the greater part of his purchases. Very often such a man is entirely at the mercy of the manure merchant, the cake merchant, the cattle dealer, the hop factor, or others with whom he has to deal; and not rarely they have such a hold on him that they can charge him practically anything they like, and can serve him with an article far inferior to that which the price paid should command. In spite of this many men who are farming successfully have passed through this stage; but this is exceptional, for the reason that they have greatly benefited by the rise in the value of farm produce which has occurred in the last two decades. Prices are much higher than they were after the great breakdown of farming in the "eighties," when, owing to loss of capital, a very large number had to give up their farms, and there were few who would place fresh capital in the land. For a few years around 1890 a man could equip a farm with live and dead stock at an abnormally low cost—far less than is required to-day. The gradual rise in price of farm produce has of course improved the value of his stock, and his capital has largely increased thereby. Many men who started farming with a small capital then have been able from time to time to add largely to their holdings. The experience of these recent years is scarcely likely to be repeated in face of the competition from abroad, and it was only possible through the exceptional, almost unprecedented, conditions which prevailed.

It is reasonable to believe that prices are now fairly stable, and the sum represented by the capital in a farm properly equipped at the present

time will act as a guide for some time to come. It was regarded at the time when British farming was in a highly prosperous condition that on a mixed farm of good agricultural land, stocked and cropped liberally in accordance with the practice on mixed farms, that a capital of £10 per acre was required. To equip a similar farm with the equivalents to-day would require a considerably less sum. A reduction in the cost or value of the substantial items can be shown in almost every instance. Decrease is generally shown in rent, the value of live stock, cost of manures and feeding stuffs, cost of horse keep, and value of crops; debatable ground is met in respect to labour, machinery, and rates. Apart from these there is little which materially affects the cost of equipment which can be regarded as increasing it. Labour and machinery, must be taken together, and while it may be urged that wages have somewhat risen and less in the way of work is returned for them, machinery has greatly lessened the quantity of work to be done by manual labour. It is not uncommon to hear farmers state that they do not find that their labour bill decreases in accordance with the increased quantity of machinery they employ. This is difficult to conceive, unless very bad judgment is exercised in the purchase and use of the machines; it is certain that a farm can be equipped with machinery which shows a profit in its use, which should materially lessen the working costs of the farm, even though manual labour be far less valuable than it used to be. Where it is not done it is probably often caused through a too partial employment of the machinery, and a prejudice which leads some to perform much work by manual labour merely because it has been customary for them to have it done so. A capital outlay of £400 may be charged with 5 per cent. for interest and 10 per cent. for deterioration; this is equal to a sum of £60 required to maintain £400 worth of machinery on the farm, and thus allows a considerable sum to be spent annually on new and improved machines. It would only be by very bad selection and employment of machines if far greater saving in labour than this could not be effected, for it barely represents the wages of a man and a half. It is probable that the ingoing valuations are rather higher than they used to be, as fuller compensations are now generally allowed, and this calls for the locking up of rather more capital.

By careful and skilful management, and in consideration of the smaller value of the ingoings and outgoings, a £10 equipment thirty or forty years ago would be covered by from £8, 10s. to £9; by specially able selection the smaller figure might possibly be reduced. Exception can be taken to this where new practices have been introduced involving additional outlay, as for instance in special farming; such as in hop growing, where permanent wiring has been substituted for hop poles, where spraying against insect and fungus attacks has become general; or in more ordinary farming, where spraying to kill charlock, or to keep in check potato disease, is practised. Again, rotations involving a much more frequent cropping of the land with catch crops, and a corresponding increase in live stock carried, necessarily adds to the expense of working and equipment. Of course, where specially valuable pedigree live stock is kept, the cost of equipment is greater, and usually more expensive methods of management are provided. It will be understood too that proximity to large market centres usually adds to the cost of rent and labour, and generally a corresponding value of the produce. Where what is known as high farming is practised, the cost of equipment may rise several pounds sterling an acre; or on poor land, badly done, so small a capital as £6 per acre may cover the mean equipment provided. Passing into special cropping, such as fruit-growing or hop-growing, £35 to

£40 is a common expenditure, and is often more. While on poor land, associated with poor sheep runs, the equipment is very much below £6 per acre. Generally the cost of equipment does not include the cost of steam-threshing tackle or of steam-cultivating tackle. Where these are purchased a material increase arises; but except on large farms it is desirable to hire these as they are required. This class of machinery is too expensive for the ordinary farmer, as they are not sufficiently versatile for his needs and are idle during the greater part of the year. The oil motor, through its smaller initial cost, and the many purposes to which it can be put, enabling it to be of service practically every day, is destined to largely supersede steam on the farm; and as they are now made in a manner which fully establishes their practicability, their use must shortly become general.

Ergot (*Claviceps purpurea*) is a fungus affecting the cereals, especially rye, and many of the pasture grasses, showing itself as a black horn-shaped growth in the ear. Massee describes the growth as follows: "Inoculation takes place when the plants are in bloom, the mycelium developing in the ovary, replacing the seed. A whitish stroma forms on the surface of the ovary, having its wrinkled surface covered with conidiophores, bearing very minute conidia. When the conidia are mature, the stroma becomes bathed in a sweet syrupy substance or 'honeydew,' which attracts insects, who unconsciously convey the conidia from one flower to another. As the conidia germinate at once, the disease, when once introduced, spreads rapidly. After the formation of conidia is completed, the stroma continues to increase in size, and becomes black externally, forming the hard, curved body known as ergot, or properly a sclerotium. Many of these sclerotia fall to the ground, where they remain in a passive condition until the following spring, when they give origin to two or three stalked bodies which produce ascospores. Some of these spores, carried by wind, alight on the grass flowers, and inoculation follows."

In Great Britain ergot is rarely found on rye in sufficient quantity to cause serious injury to men or animals consuming it, though on the Continent and in America diseases due to it are common, sometimes taking an epidemic form, as during the siege of Kustrin, when the garrison was decimated through eating meal made from ergoted rye; or again, in the United States more recently, a wholesale epidemic, at first thought to be foot-and-mouth disease, broke out among cattle, and it was found to have resulted from eating ergotised food. On the Continent deaths from eating ergot ground with rye to make rye bread are frequent in the rye-eating districts. As a rule, the disease takes the form of gangrene of the extremities. It, however, serves useful purposes in medicine, and is largely used to bring about parturition in cases where the natural effort is weak; its action differs, however, from the natural spasmodic efforts, for while it is operating it is practically continuous. It is also useful as a means of preventing bleeding. As its use as an aid to parturition, when an animal has gone its full time is well known, it has been assumed that it is a frequent cause of abortion or premature birth of calves, but direct evidence in favour of this is not ascertainable; in fact, in thorough trials no results have been obtained to support the opinion. A few years since a large amount of information was gathered in respect to a widespread epidemic of abortion among cows in the Midland counties of England, and at the time it was held by many that there was sufficient evidence that ergot in the pastures and hay was the cause. However, it is difficult to find districts

where there is not a considerable amount of ergot. This was before it was understood that abortion was commonly due to specific germs. Since this discovery, together with the support it has acquired by the success of methods to destroy the germs, few regard ergot as a serious cause of abortion. Should a district become much affected by ergot, and it is thought desirable to keep it in check, this can best be done by mowing off the flowering heads of grasses before the ergot appears, or when it is appearing; being a disease which affects the flowering heads, it cannot develop if they are kept down. It is only late in the season as a rule that ergot is much in evidence, therefore the first crop need not be regarded, attention being given to the aftermath, or bunches of grass left by animals when grazing. Having lived in districts where ergot is very common, and never having seen any injury which could be attributed to it, we have never felt there was necessity to take steps to keep it in check.

Exmoor Horn Sheep.—This breed, which is one of the principal in the south-west of England, has existed from time immemorial in the hill country known as Exmoor, in West Somerset and North Devon. Charles Vancouver in a report on the agriculture of Devon, printed in 1808, states that—

"The common Exmoor sheep are the breed most generally preferred in the open and more exposed parts of Exmoor. This preference arises from their extraordinary hardiness and the activity with which they continue working in search of food. The wethers of this breed at two and a half or three years old are fattened to their frame, make delicious mutton weighing from 12 to 15 lb. per quarter, and commonly shear from 4 to 5½ lb. of washed wool to the fleece (value 9d. per lb. in the yoak; washed wool, 13d. to the pound). A horned animal, with a moderately long staple of wool, which heretofore and before the cloth manufacture fled from this country into Yorkshire was much used by the clothiers of North and South Molton, Dunster, Wiveliscombe, Cullompton, and other places. Particulars of a cross with the merino, the third cross wool being three times the value of the native fleece, and the carcass is said to be rather advanced than otherwise. . . . They appear to resist the storms of the country equal to the native sheep. Crossed with the Leicester wethers at three years old realised 24 lb. a quarter and carried 6½ lb. of wool (yoak). Giving the character of the Exmoors as horned with white legs and face, with a moderately long staple of wool; wethers if slain at thirty months old give an average weight per quarter of 15 lb.; the average weight of fleece, 7 lb. of "yoak" wool, price 10d. per lb.; value of fleece, 5s. 10d.; rough fat, 7 lb.; kidney fat, 5 lb.—total inside fat, 12 lb."

Professor W. E. S. Spooner in 1844 writes that Exmoors and the Dartmoor sheep are the principal forest breeds in the West of England. Located in the higher situation of Devonshire, they are a hardy race adapted to the poverty of pasture which the forests of Dartmoor and Exmoor afford. Though bred on the heath, they are fattened in the plains, and their mutton is highly praised for its excellence, and commands a ready sale both in the neighbouring and distant markets. Exmoors drop their lambs very early, and have the reputation of good mothers for production of fat lambs for the London markets.

Mr. Dixon, in 1871, speaking of the breed, states that in the Devon side of Exmoor there were several large flocks, Mr. Maunder owning 2500.

Some of Mr. Quartly's sheep averaged 29 lb. per quarter at four years old. Under high pressure they have done wonders of late years. One of Mr. Tapp's first prize pens at Smithfield reached 42 lb. a quarter. This only applies to well-kept sheep in an exceptional year. There is no trouble in getting them to feed, although they are naturally hardy. A 10 lb. fleece has been cut off a tup for four years in succession, but such instances are rare. These extraordinary weights of carcasses must, too, be deemed wholly exceptional, only showing of what the breed is capable in improved conditions and fed on the best of food. From 15 to 18 lb. a quarter is much nearer the weight of a carcass obtained by hill-country farmers, and 5 lb. of wool.

The Exmoor Horn Sheep Breeders Society was formed on the 28th July 1906, and the Society was incorporated under Rules and Byelaws as approved by the Board of Trade.

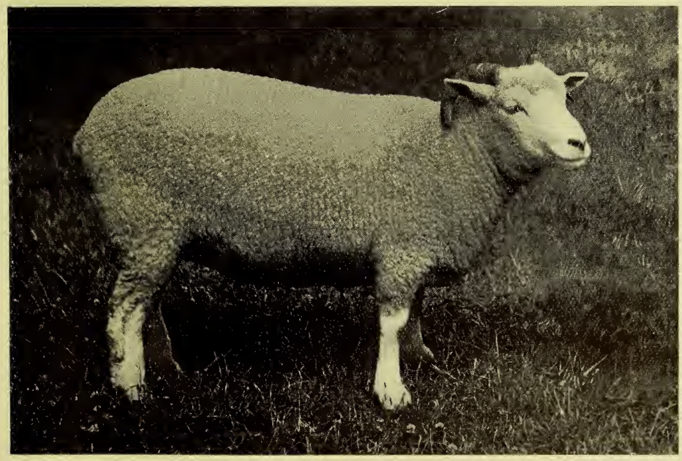
Between the above date and the present upwards of 130 members have been enrolled and upwards of 18,000 pure Exmoor horn sheep branded with the anchor mark, which for three-quarters of a century has been the mark used for the Exmoor pony herd, and was consequently considered appropriate for the purpose.

The Royal Agricultural Society of England and other leading Agricultural Societies have recognised the Exmoor horn sheep as a distinct variety at their respective shows.

The Society embraces all the well-known breeders of the pure Exmoor horn sheep, and it is interesting to note the very large number of flocks that have descended from father to son and sometimes to the third and further generations. Many of the farms in the Exmoor district have an altitude of from 1000 to 1400 feet above sea-level, and farmers so situated are naturally careful to breed sheep with hardy constitutions and storm-resisting wool. This must necessarily be of a dense character, so as to well fill the hand on grasping it, and this is well expressed by the old country saying that hailstones should rattle off it. The average weights of washed wool clipped may be taken as—a good ram not less than 10 lb., and the ewe flock should average 6½ lb. a piece or more if well kept. The wool has a greater market value than any of the other local breeds, and is generally sold locally, the best going as "tops" to the great wool centres, while the remainder is made up into the far-famed West of England tweeds and serges. The quality of the mutton is quite first class, and the local butchers who kill it do a large trade in sending mutton to various customers all over the country. The wethers are usually killed at about sixteen months, and should weigh from 14 to 17 lb. a quarter. The old merino cross is again being tried in South Africa, shearling rams having been exported there for crossing with a merino flock. A report just to hand states that they have worked more successfully and have stood the climate better than any other breed has hitherto done. The ewes, from their natural hardihood, are good mothers, and give a bountiful supply of milk. They come in use early, and are much used for crossing with larger breeds such as the Hampshire and Shropshire Downs and others, to produce early lamb. Large numbers of the draft ewes are purchased for this purpose at the summer draft stock sales, and are found very profitable by farmers in Wiltshire and the surrounding counties. They winter well on rough grass without any roots, clearing up pastures and thriving where most other breeds would starve. They rear strong, healthy lambs, which require little or no artificial food to bring them to nice weights for the butcher. After weaning, the ewes fatten easily and quickly. The Society held its first sale of registered sheep at Winsford on the 20th August

Reid.

Exmoor Ram.



Reid.

Exmoor Ewe.

1907, and there was a large unsatisfied demand for draft ewes, at prices which averaged about 44s. per head for good specimens, and which rose to 48s. at the close of the sale. The foundation of the Society has given a great impetus to the breeding of this old-established native variety, and it is already apparent that much more care is being bestowed upon the selection of animals for stock purposes, which will increase the already keen rivalry among flock owners of all sizes, and will lead to a great levelling up of the various flocks to the highest standard of quality and type.

As instances of the present prices of Exmoor horn sheep at the dispersal of the late Amos S. Lovelace's flock, in September 1906, registered ewes made from 36s. 6d. to 62s., and ram lambs up to £8, 15s. At Barnstaple Fat Stock Show lambs made 63s. a head.

The Honorary Secretary of the Exmoor Horn Sheep Society is Mr. D. J. Tapp, Highercombe Farm, Dulverton, Somerset, where the registered offices are situate.

Exmoor Ponies.—Exmoor has always been famous for its ponies. They are believed to be the descendants of the ancient British cavalry and chariot horses which were so effectually handled in the time of Julius Cæsar, and mentioned by him in his Commentaries. These, in turn, are said to have been originally brought to Britain by Phœnician traders in search of tin upon the Devon and Cornish coasts. The Saxon invasion gradually drove the Britons westward towards Cornwall and Wales, and it is certain that they would carry their horses with them.

If it is objected that the small size of Exmoor, Welsh, and Forest ponies is inconsistent with prowess in war, it must be remembered that hard living and high altitudes rapidly diminish the stature of the horse. The Puno ponies of the Cordillera Mountains may be cited in support of this statement, as they are known to be the direct descendants of the Spanish horses used in the conquests of Peru and Mexico in the sixteenth century. This point is settled by the fact that the horse was unknown upon the American continent when it was discovered at the close of the fifteenth century. Horses are always of pony size in small islands and in mountainous regions, as, for example, in the Falkland Islands, Corsica, Shetland, or in Wales, Norway, Devonshire, Galloway, and the Highlands of Scotland. All these countries boast hardy races of ponies. So also does the New Forest, an area which although not properly described as mountainous, necessitates frugal or hard living. The presence of ponies upon the exposed and elevated tableland of Exmoor is therefore satisfactorily accounted for and reconciled with traditions of larger size and prowess in the battlefield. Our recent experiences in the Boer war clearly show that cavalry composed of small horses or ponies is wonderfully mobile and possessed of great endurance and hardihood. Having accounted for the existence of the Exmoor pony, we now proceed to consider very briefly its recent history, its points, and its qualities. With reference to its modern development, various attempts have been made to improve the stock by importations of foreign blood, but without success. Katerfelto is still remembered in Devonshire as a sire gifted with that wonderful prepotency or power of transmitting his own likeness to his offspring which characterised the bull Hubback among shorthorns, and Eclipse among thoroughbred horses. Katerfelto is said to have been foaled by a beautiful black Galloway mare belonging to Mr. Abel, a surgeon at Tiverton, in 1778. She became the property of Mr. Stanell, who bred a colt from her by a horse called Sportsman, then serving in the parish

of Olseford. Mr. H. H. Dixon (The Druid) states that "Katerfelto's dam, after being stolen by gipsies, was recovered, in foal with him, by an arab." Whether the horse Sportsman and the arab were one and the same must remain doubtful, but it appears to be certain that the colt was purchased by Sir Thomas Acland, who christened him Katerfelto, after the celebrated conjuror of that name. Katerfelto was very widely used as a sire, and lived to the age of twenty-six. Dr. Collyns, in his work on *The Chase of the Red Wild Deer*, observes, that "the thanks of the community are due to Sir Thomas Acland for keeping up the breed of that diminutive but truly thoroughbred animal the Exmoor pony." Later efforts to improve the Exmoor ponies by the use of English thoroughbred sires do not appear to have been in all respects successful, as the progeny and their descendants were found unable to stand the winters of Exmoor as well as the old blood—to which there was consequently a return. The pure Exmoor ponies are described as of buffy-bay or darkish-brown colour, with mealy nose; and are generally under 14 hands in height, thicker through than the New Forest pony, and showing more blood than the Welsh, while the Highlander is a mere carthorse by the side of them (J. Nevill Fitt). The Devon farmers are jealous as to their own favourite strains of blood, and take great pride in these little horses, which are able to carry full-grown men after the wild deer, and to exhibit extraordinary endurance in the chase.

Factories.—*See* Creameries.

Fallow Crops.—The term "fallow crops" seems at first sight to involve a contradiction, as "fallow" naturally implies a period of rest and inaction. In the ancient sense, fallowing was a passive means of restoring fertility, by allowing time for the operation of atmospheric forces. It was at a late period assisted by tillage and manuring, but it was not until the closing years of the seventeenth century that cropping was introduced as a further means of making fallowing efficient. The general tendency was expressed by what became generally known as "turnip husbandry," and in process of time other root and fodder crops were introduced, until the modern idea of "fallow crops" became generally accepted. It is not intended in this article to give the history and cultivation of these crops in detail, as they will be considered under various headings, to which the reader is now referred. Our present object is rather to consider these crops in their relations to the recuperation and the improvement of land, and in this connection it is necessary to point out that no crop is worthy of the title of a fallow crop, unless it conforms to the following conditions. In the first place, it must be consumed upon the premises, as otherwise it becomes a depleting crop. The fact is, that many fallow crops are in themselves exhausting to the land in a higher degree even than corn crops. Turnips, swedes, and mangel-wurzel remove a much greater weight of phosphoric acid, potash, and nitrogen from the soil than wheat or any other cereal; but being eaten upon the holding, they not only restore what they have removed, but being fed in conjunction with concentrated foods, they more than replace what they have absorbed from the land. Taking these

principal crops as examples, and contrasting them with cereal crops, we find that the following figures fairly represent the actual case:—

Crops, including Leaves and Straw.	Ingredients required for Producing the Crop per Acre, in Pounds.			
	Nitrogen.	Phosphoric Acid.	Potash.	Lime.
Turnips 17 tons per acre . . .	110	33·1	148·8	74
Swedes 14 ,, ,, . . .	98	21·7	79·7	42·4
Mangel 22 ,, ,, . . .	149	52·9	300·7	42·9
Wheat 30 bushels per acre . .	50	21·1	28·8	9·2

The above table not only shows the exhausting nature of three typical fallow crops in comparison with wheat, but explains why root crops cannot be grown successfully without their being liberally manured. They are grown at a period in which land requires renovation, and, strange as it may seem, it is asked to produce crops of an extremely exhausting nature, when it is in an exhausted state. In most cases the land has been winter-fallowed, *i.e.* ploughed during winter, and has received the winter's rainfall, which, as is well known, washes away a considerable proportion of soluble nitrates out of the soil. This further increases the depletion before the period arrives for sowing root crops, and the great demands made upon the soil during their growth are made when it is exhausted by previous crops. These considerations show the importance of manuring root crops, and also give rise to reflection. There can be no doubt that the condition of the soil with regard to fertilising ingredients controls its producing power, and we may well ask why particularly exacting crops should be used for renovating purposes, and why an ordinary grain crop well supplied with fertilising matter should not be substituted instead? This, in fact, is an argument in favour of consecutive corn-growing and the abandonment of fallowing. It is impossible to give a satisfactory answer to these questions if stated as general principles, and they have been solved in many cases by relinquishing fallowing in favour of repeated crops of grain assisted by artificial fertilisers. There are, however, many collateral circumstances to be considered which affect these questions, as, for example the requirements of live stock, the peculiarities, of various descriptions of land, and the important consideration of cleaning land.

Fallowing crops form an important part of any system of mixed farming in which live stock constitute an important item; and, if cattle and sheep can be shown to be profitable in themselves, and are not simply looked upon as a means of increasing the yield of corn, the matter is solved in favour of fallowing crops. We have, however, been so often assured that live stock are principally useful in keeping up fertility, and that, in themselves, and apart from this consideration, are a cause of loss, that there are cases in which the value of fallowing crops may be called in question. On certain classes of clay land well adapted for corn and not suitable for roots, fallowing crops may be considered as an unnecessary link between corn crops. That the land requires "rest" cannot in these days be believed. If so, it seems

unreasonable to burden it with the most exhausting crops possible just when it most needs assistance. Again, if assistance, in the form of manure, enables it to grow a heavy root crop, why should not the same, or less, assistance enable it to carry a corn crop?

These arguments cut at the very roots of the question, and, as already stated, give rise to very serious reflection. If, however, a farmer is convinced that live stock pay better than corn, he will have no doubts as to the value of fodder crops, but rather increase their area, and continue to grow corn on one-half of his arable land, or less.

The benefit of close-folding sheep upon the lighter classes of land consists partly in the consolidation of the ground, and for this purpose fallow crops are necessary. The mechanical effect of sheep upon the texture of light soils is exceedingly beneficial, and those who have tried to do without them have generally found out their mistake in a very few years. The treading of sheep upon heavy land is often injurious, and for this reason the bare fallow is sometimes preferred, and this entails an abandonment or reduced area of root crops. There is, however, a class of summer fallow crops, which we shall presently consider, not open to this objection, as they are consumed in dry weather.

Lastly, there is the system of carting off root crops for consumption in yards. In this case the land must be severely depleted by the removal of so many pounds of fertilising matter, which must be replaced, either by heavily dunging for roots before they are grown, or after they have been drawn away. This involves double expense, first in removing and storing the roots, and secondly in carting back the manure.

Fallowing crops include various plants besides the ordinary root crops, such as rape, kale, kohl-rabi, cabbage, carrots, and parsnips, all of which are cultivated upon the fallow breadth. They may, for the present purpose, be considered together, but are treated of elsewhere in this work. The first point to be noticed is that they are all sown comparatively late in the season. The bulk of these crops are drilled during May, June, and July. In some cases sowing extends into August, and may be commenced in April, but in either case sowing is undertaken after spring corn-sowing and before harvest. This allows of autumn, winter, and spring cultivation, and the thorough cleaning of the land; so that root crops do not interfere with this principal object of fallowing. Liberal manuring is essential to success, and thus another point of fallowing is secured. The wide drilling or raised ridges used in turnip husbandry enable hoeing and interculture to proceed after the plants are in row, so that during the entire preparation and after cultivation of these crops the principles of fallowing are strictly observed, and, after the crop has been eaten by sheep and ploughed up for corn, every requirement of thorough cultivation, manuring, and freedom from weeds has been secured.

Fallow crops other than root crops.—Reference to the articles on catch crops and forage crops will assist the reader to understand the cultivation of these crops. They are, however, only truly fallowing crops if they promote the three objects of fallowing, namely, the thorough pulverisation, enriching, and cleaning of the land. If used as catch crops, they interfere with the first and last of these objects, for it is impossible to fully expose a soil to the influences of frost, if it is sown with winter vetches or any other catch crop. Similarly, it is impossible to thoroughly clean a field which is occupied by a crop from September to May, and is then to be folded by sheep and hurriedly prepared for roots. Land so treated is generally more or less foul, although in some cases cleaning is performed between harvest

and sowing, and there is occasionally an opportunity for cleaning land between eating off the catch crop and sowing the root crop. The writer cannot therefore view the catch-crop system as entirely consistent with the fundamental ideas of fallowing. A relief from the difficulty is found in omitting the root crop after the so-called catch crop,—in fact, to abandon the idea of catch-cropping, and to substitute for roots a half, rag, or bastard fallow. In this case the forage crop, sown in the autumn, is fed off with sheep, and the land is then thoroughly ploughed, cultivated, and cleaned during summer, and made ready in good time for wheat. This is a good system when the land is foul, and may be stretched, so as to include trefoil and "seeds," which are first either fed off or mown, and then fallowed up and prepared for wheat.

One of the strong points in connection with fallow crops is the facility they afford for consuming cake, corn, and hay upon the land, and thus introduce a more intensive method of manuring than can be contemplated under the bare fallow. Sheep, consuming a fair root crop, and eating half a pound per day each of cake will at the rate of 250 sheep per acre per week consume $125 \times 7 = 875$ lb., or nearly 8 cwt. of cake, and probably 1750 lb. of hay per acre. This very heavy dressing is to be added to the fertilising matter restored to the soil through the consumption of the root crop, and easily accounts for the benefits of close-folding and of the cultivation of fallow crops. These crops certainly show to the greatest advantage when sheep are folded upon them, but when the root crop is to be removed for bullock feeding the advantage is less evident. There indeed appears to be some reason in the case of heavy land to prefer the bare fallow to root cultivation, and if this is allowed the question of consecutive corn growing with the help of artificial manures threatens to do away with fallowing altogether.

Mention has been made of the advantage of a certain class of fallow crops which may be consumed upon the land in the summer months, and this leads us to consider *fallow crops for summer use.* These include, first, winter vetches and other autumn-sown forage crops (*see* Forage Crops), but also, and in a special degree, rape, kale, and cabbage.

All of these crops are suitable for summer feeding on clay land, and are also naturally suitable for growing upon such land. Thus cultivation need not be enlarged upon here, but a few remarks upon cabbage will not be out of place. Cabbages are most successfully cultivated by growing them in seed bed and transplanting them out into open fields. (*See* Cabbage.) This system is consistent with the best traditions of fallowing, as the future cabbage field may be thoroughly cleaned and manured in the early autumn, while the plants are growing in the seed bed. They are then planted out without injuring the land, and vacancies are replaced in the winter and early spring from the bed. The crop is hand- and horse-hoed in the spring, and will be ready for folding in June or July. The land is ploughed and dressed for wheat-sowing in September, and may then be regarded as well fallowed and renovated, and fit for a course of cropping.

Farcy.—*See* Glanders.

Farmyard Manure.—The superiority of farmyard manure over other fertilisers is an article of faith with the majority of practical farmers. It is not by any means clear, on scientific grounds, why it should be so universally preferred before other manures, and it is only by attacking the question, and discussing it from various points of view, that we can arrive

at a just estimate of its intrinsic and comparative merits. Farmyard manure is so well known as to render a definition superfluous; but a very little consideration will show that it must vary enormously in quality, according to the conditions under which it is produced. It may be entirely derived from straw, if it is the product of cattle eating straw and littered with the same material, a system frequently adopted with store cattle and dry cows. Such cattle can live on good oat straw, and, if well bred, manage to keep up their condition in a truly wonderful manner, without any other food except water. The case is only cited in order to show that manure so produced can only contain the elements of straw, and that it must be deficient in those materials which are specially required for the production of grain, such as phosphoric acid and nitrogenous matter. Farmyard manure which is "strawy" in character is very inferior to that which is enriched by feeding materials, such as cakes and meals, hay, and nitrogenous foods, generally made under cover, and with the addition of limited amounts of straw. "Dung," to use a familiar synonym, derived practically from straw only, and exposed to the weather until its soluble parts are washed away by the rain, is seen at its worst; and such manure is not held in high estimation, even by those who are most strongly prejudiced in its favour. The difference between such farmyard manure and that which is produced by mature bullocks, fattened in boxes or covered yards, receiving liberal allowances of cake, sheltered from the weather, and requiring a minimum amount of litter, is enormous, and is thoroughly appreciated by farmers. Between these extremes all degrees of difference exist in the quality of dung, and it is therefore impossible to rely on any analysis as truly representing its composition. A more general view is more helpful than a purely chemical estimate, and it will be presently shown that composition is only one of the many conditions to which its great value is attributable. When formed under the most favourable conditions, it contains all the constituents of plants; being derived from the straw, *plus* the grain. It is rich in potash from the former, and in phosphate and nitrogenous matter from the latter. It naturally contains lime, magnesia, nitrates, sulphates, chlorine, silica, soda, and, in a word, all the ingredients of plants; and by implication all the ingredients which plants remove from the soil. It is therefore entitled in a special degree to be considered as a general manure, by which is not meant a manure for general use, but a manure which may be compared to a general food, like milk, which is capable of fully feeding an animal. In the same sense good farmyard manure is so composed as to keep up and maintain the fertility of all soils, and to feed all crops. The amount of the ingredients of food retained by the animal for its growth is extremely small, as is readily shown by the constant passage of food in large quantities through the system, and the comparative slowness of growth; while the accumulation of fat, in fattening animals, really makes no call at all upon the manurial properties of food. Still, it may be pointed out in this connection, that growing animals, and cows in milk, extract a much more appreciable amount of the fertilising materials of the food supplied, and that their manure is proportionately of less value than that of mature fattening animals. This point is of importance, not only as affecting the quality of the manure produced, but the question of "compensation" for foods consumed on the holding by an outgoing tenant. The value of dung as a plant food is not dependent upon its bulk or mass, but upon the fertilising constituents it contains. It is certain that these constituents must be presented to the rootlets of growing plants in the condition of pure gases and salts released from organic combination by

natural decomposition and decay. To imagine that a plant can feed upon the gross and offensive mass of dung, like an animal consuming carrion or garbage, would be absolutely wrong. It is through the gradual evolution of carbonic acid gas, nitrates, phosphates, and other salts derived from the complete decay of the dung, and dissolved in water, that plants are nourished. Thus the plant lives on pure salts, and not on dung as such; and time and thorough decomposition and incorporation with the soil are necessary before the full value of dung can be realised. It is at this point that we may not unnaturally ask, Why, if such is the case, dung should be superior to artificial manures composed of the same salts and presented to the roots of plants in watery solution? The answer to this question is, that there is no difference. It is precisely at this point that artificial manure and farmyard manure meet on common ground. There is no reason why nitrate of soda should not act as effectively as the nitrates in dung; or why soluble phosphates in the form of superphosphate of lime should not tell as effectively upon growing crops as the phosphates liberated from dung. They probably act as certainly and as efficiently, and it is possible that they may act more economically. Both classes of fertiliser are of value, and both are esteemed in practice. But dung possesses properties peculiar to itself, and no doubt the same thing may be said of artificial manures.

The Mechanical Effect of Farmyard Manure.

The bulk or mass of farmyard dung is one of its characteristics. Its active ingredients represent a very small proportion of its weight or its volume, and its bulk is principally composed of water and carbonaceous matter, neither of which are in the ordinary sense fertilising matters. Water cannot be priced out like nitrogen or phosphoric acid; but, in many cases, the moisture contained in farmyard manure directly assists in the germination of seeds, as, for example, in turnip drills, split over a dressing of dung. The power of humus or vegetable matter in a state of decay to attract and hold moisture is well known, and land which has received repeated dressings of dung possesses more hygroscopic power of retaining moisture and resisting drought, than it would possess if only dressed with artificial manure.

As to the carbonaceous matter in dung, it is rapidly oxidised, and during the process it evolves carbonic acid gas, which enters into solution in the soil water, and enhances its solvent power upon the mineral matter of the soil. This is a function which deserves special notice. It accounts in some degree for the beneficial effects of dung, in comparison with artificial manure; but it is evidently of an *exhausting* nature, so far as the soil itself is concerned. It is impossible to deny that if the evolution of carbonic acid gas within the interstices of the soil dissolves and renders available the mineral food within the soil, that it tends to soil exhaustion in this respect. If nitrate of soda calls upon the other elements of fertility in a soil to an immense degree, and can be accused of exhausting it, we must allow that farmyard manure owes some of its effect to a similar call upon potential fertility. It is no detriment to farmyard manure that such should be the case. The sooner the fertilising elements can be whipped out of a soil the better, provided they are replaced by liberal manuring as fast as they are drawn out. The point is only mentioned because it has been objected to in the case of nitrate of soda, as the writer believes unreasonably, because the object of agriculture is to grow heavy crops, and at the same time to restore and increase the fertility of the soil.

All organic matters derived from decaying animals and plants, or from animal excrements, like dung, are rich in nitrogen. The nitrogen in farmyard manure is not yet in the state of nitrates, but it is partly present in the form of ammonia and more abundantly as nitrogen in organic combination with vegetable tissues. A closer study of dung reveals the fact that it is composed of organic matter in three conditions. First, in an extremely fine state of division either dissolved or suspended in the liquid manure of the dung. This is the most available portion of the manure. It contains ammonia, which rapidly passes into the form of nitrates of lime or other bases, under the influence of the nitrifying bacteria. It is the portion of the dung which acts most powerfully immediately after application. Secondly, there is the finely masticated food residues, which have passed through the alimentary canal as fæces, and which are only one degree less readily available than the liquid manure. Thirdly, there is the coarser, bulkier, and tougher litter, in a more or less rotted condition, which decays much more slowly, and lasts for many years. The effect of this triple combination is that dung acts immediately and continuously, and that many years elapse before its effect is entirely exhausted. Certainly, at Rothamsted, dressing of dung applied fifty to sixty years ago can still be traced in a maintained increase of crops year after year without showing any sign of absolutely stopping.

The constitution of dung, just explained, indicates that it continues to evolve fertilising matter during its decay, not only of a nitrogenous but of a mineral character. Nitrification has already been alluded to, but is so important as to demand fuller notice. It may be defined as the natural formation of nitrates, from nitric acid evolved from decaying animal and vegetable matter, in presence of a salifiable base, such as lime. This is the principle of "nitre-beds," and it is in continuous operation in all fertile soils. Dressings of farmyard manure increase the action which takes place in all cultivated soils. The point of greatest importance, so far as dung is concerned, is that the action is arrested at temperatures below 40° Fahr., and that it is most active in temperatures most favourable to germination and growth. Hence it so happens that when land is rich in organic matter (dung) the greatest development of nitrates takes place just at the time of year when it is most required for growing crops, and that the formation of nitrates is practically stopped during winter. This may be regarded as a beautifully regulated supply of nitrates, which is turned off and turned on as required, and is identified in a special degree with the use of dung. The nitrates from dung are developed as needed, whereas if applied in the form of nitrate of soda, they are more liable to be washed away by the rain. In the case of farmyard manure they are developed continuously and in such small quantities that the network of root fibres can at once appropriate them. We have still to notice the mechanical effect of dung upon the texture of the soil. Especially when applied in the long condition, dung lightens up stiff clay soils. This is not, properly speaking, a manurial effect, but rather one similar to tillage or pulverisation through drainage or through the action of frost. Any effect of this nature, viewed apart from the manurial properties of dung, must be exhausting rather than renovating, as it is a reaction upon the potential fertility of the soil, and may be taken in connection with what has been already said upon the dissolving effects of farmyard manure upon the mineral plant food already existing in the soil. The mechanical effect is due to the decay of haulm and strawy matter, which opens up capillary spaces in the soil, and overcomes the tenacity of the particles of clay towards each other. In the case of light sandy soils, the

organic matter acts as a cement, and produces coherence among the soil particles, and increases their power to hold moisture. Lime is credited with a similar power of opening clayey soils and binding sandy soils, which is simply due to the fact that it is intermediate in consistency. It is the combination of chemical and mechanical properties which places farmyard manure in its paramount position.

Denitrification.

Of late years farmyard manure has been accused of favouring denitrification, or the union of the oxygen of the nitric acid with carbon, to form carbonic acid, while the free nitrogen escapes into the air. It takes place in water-logged soils, but also in the presence of decaying vegetable matter, in soils accessible to air. This case fits that of a soil which has received a heavy dressing of farmyard manure, and, as far as it occurs, it is objectionable. If it acted beyond a very limited degree it must have long ago militated against the reputation of dung, but it appears rather as a scientific fact than a practical objection, and is overridden by the evident advantages of dung as a manurial agent. It points to the advisability of using dung in moderation; for if the effect is practically injurious, it is likely to be in cases in which an inordinate amount of decaying vegetable matter has been applied to the land. (*See* Denitrification.)

Drawbacks from the Use of Dung.

As there is a certain degree of rivalry between the partisans of dung and of "artificials," it may be advisable to put the case of these two classes of fertilisers before readers. Dung is a universal manure, fitted for all soils, all climates, and all crops. It is, however, in some respects wasteful, when contrasted with certain definite requirements of crops. When phosphates have been removed for centuries from grass land in the form of bone-earth, it is wasteful to attempt to correct the want by copious dressings of dung. Or, if nitrates are distinctly wanting in a soil, there is no reason why a dressing of nitrate of soda or sulphate of ammonia should not be used in preference. Again, where a crop is grown which requires a special fertilising element in excess, such as potash for potatoes or clover, or phosphoric acid in the case of turnips, or nitrates in the case of wheat, it would seem wasteful to rely on dung. There is, in fact, no better way of increasing the stock of farmyard manure upon a farm than by using such artificial manure for promoting the growth of hay, straw, and roots; and thus increasing the capability of the holding for maintaining an increased head of live stock. This fact is evidently overlooked by those who decry the use of artificial manures, and pin their faith too exclusively upon farmyard manure; and it ought to silence those who see in nitrate of soda a "stimulant" which causes the crop to rob the land. It has been shown in the previous remarks that even farmyard manure is not entirely free from this charge.

Expense of Dung.

The cost of dung depends upon the profit or loss upon the animals producing it. It is impossible to go at length into the cost of producing dung. If the cattle pay their own expenses, the dung may be regarded as a by-product, obtained free of cost. If the cattle only pay through the dung they leave, and are otherwise a loss, then the manure is produced at a certain cost. The question as to the market price of straw is germane to that of the cost of producing manure; for if straw will make 50s. or 60s. a ton, there is an argument against crushing it down in yards.

As to the cost of haulage, it is no doubt considerable, and under some circumstances prohibitive. The contrast between 5 cwt. of superphosphate at 3s. and dung costing quite as much for its mere application, apart from the cost of production, is rather startling; but it must always be remembered that dung carting is often a god-send to the farmer in wet and frosty weather, when the horses would otherwise be idle; and that it is scarcely reasonable to charge horse labour at full rates for such work.

Amount of Dung produced.

There is no fear of too much dung being produced upon a farm, and it seldom happens that more than one-eighth part of the area can be dunged in one year. The straw is the best measure of the amount which may be produced. To be as brief as possible, we may assume that about 1 ton of straw will be grown per acre, and 200 tons upon as many acres. If, on an outside estimate, this weight of straw were all converted into "muck," it is known that when saturated with moisture and excrementitious matter, it could only produce four times its weight of fresh dung, which would rapidly lose weight through rotting. The maximum quantity of dung produced on a farm of 400 acres (arable) growing 200 acres of corn would therefore be 800 tons, subject to several important deductions. Fresh dung loses half its weight in rotting, and if any straw is sold or eaten by stock, the amount available for litter will be reduced. It is therefore probable that the weight of dung produced upon 500 acres of land, 400 acres of which are arable, will not exceed 600 tons, which amount could only manure 60 acres at the moderate rate of 10 tons per acre. There is therefore evidently room for the application of both dung and artificials on all farms.

Application of Dung.

With a limited quantity, it is important to bestow farmyard manure on those parts of the farm that need it most. If we assume, for convenience, that the arable land is worked upon a four-course system, it is impossible to manure more than a portion of the root and wheat land. The land intended for potatoes, mangel-wurzel, and any roots which are intended to be carted off for cattle, ought to be dunged; and as much of the wheat land as possible. There is economy in carting dung on to land near to where it is produced, or near the homestead; and the roots upon the more distant fields are better raised with the help of superphosphate, and close folded on the land with sheep. A system of field yards, or scattered buildings, in which manure is made at various centres, is helpful as regards the carting of both roots and manure, and assists materially in getting dung into all the fields.

In former times, when arable land paid better than it does now, the dung was in the first place carted into heaps and turned once, or even twice, in order to produce well-rotted manure. It was, however, pointed out that the loss of weight and bulk from fermentation was a manifest disadvantage, although the value per ton was increased. It is impossible to rot dung without losing a good deal of nitrogen in the form of volatile carbonate of ammonia, and, although this loss was exaggerated, the extra labour was another and more serious objection. With the movement in favour of autumn cultivation, which came into vogue after 1840, was associated the practice of applying the dung as much as possible before winter, so that it might be ploughed in and thoroughly incorporated with the soil, before the root crops were sown. The autumnal application of dung on land intended for roots, and the dunging of land intended for wheat, both tended

towards the practice of carting it from the yards direct to the land without making it into heaps; and by this system the entire bulk of the manure was enabled to rot in the land, and to benefit it by the decompositions already explained. Well-rotted dung is now restricted to special cultivation, and to its application to meadows and pastures, where long straw left on the surface is objectionable. All the directions as to the management of manure heaps, the turning, watering, and covering with earth, etc., recommended in the earlier text-books, are now scarcely in accordance with the practice of the best farmers, which, as a rule, is to let the dung alone until it is carted straight to its ultimate destination. Recent experiments have demonstrated that heavy dungings of over 20 tons per acre are extravagant, and may lead to denitrification within the soil. Moderate dressings, spread over a wider area, say of 10 to 15 tons per acre, and more frequently repeated, are better than those heavy applications which formerly were used. (*See also* Bacteriology.)

The Cash Value of Farmyard Manure.

The variations in quality and composition of farmyard manure render it impossible to assess its actual cash value with accuracy, but certain figures are adopted in practice which are supposed to represent the value of good farmyard dung. Five shillings a ton is a common estimate, when attempts are made to value the cost of cultivation, and 3s. a load is frequently given for ordinary dung in place. Such figures are meant to represent, in some cases, cost of production, while in others they are true representations of prices paid or received. The actual value of dung to the land, in the form of increased produce, is probably a great deal more, and certainly need not bear any rigid proportion to estimate of cost, say in fattening bullocks, or prices paid to a neighbour for taking up a few loads of manure. The fact that bullock feeding in winter is in many cases professedly carried on, year after year, for the sake of the manure, infers a greater *value* than 5s. a ton —for such a figure would scarcely be an inducement to convert straw and roots into dung. It is the far-reaching effect of dung upon future crops which render estimates of value fallacious, and probably, in most cases, insufficient. Those who study the late Sir John Lawes' most able papers upon the "Valuation of Unexhausted Manures" must be struck with the evidence produced as to the protracted effect of dung upon land at Rothamsted. Two cases especially may be cited. The first refers to the effect of dung upon permanent grass where it was applied for eight years (1856–1863) at the rate of 14 tons per acre; and this is contrasted with a neighbouring plot which was continuously unmanured from 1856 and onwards. The following table indicates the permanence of the effect of dung:

	Unmanured every Year (1856–1863).	Farmyard Manure, 8 Years (1856–1863), and Unmanured since.	Increase from Dressings of Dung discontinued after 1863.
	Hay.	Hay.	
8 years (1856–1863), 1st crops only	$23\frac{1}{2}$ cwt.	$42\frac{7}{8}$ cwt.	$19\frac{1}{8}$ cwt.
12 years (1864–1875), 1st crops only	$19\frac{5}{8}$,,	$32\frac{7}{8}$,,	$13\frac{1}{4}$,,
20 years (1876–1895), 1st and 2nd crops, if any	$25\frac{7}{8}$,,	$29\frac{7}{8}$,,	4 ,,

From these figures it seems that dung applied at the rate of 14 tons per acre from 1856 to 1863 was still acting on the produce thirty years after it was discontinued, in the very appreciative form of extra hay per acre. A similar case is given of barley. In one case barley was grown continuously upon the same land from 1852 to 1896 without any application of manure of any kind. In the other closely contiguous plot the land was manured with 14 tons of farmyard manure from 1852 to 1871, or twenty years, and was then unmanured for the twenty-five years ending in 1896.

The duration of the manurial effects are shown as follows:

	Unmanured every Year (1852–1896).	14 Tons of Farmyard Manure per Acre, from 1852–1871, and Unmanured since.	Increase over continuously Unmanured.
20 years (1852–1871) .	20 bushels.	48¼ bushels.	28¼ bushels.
20 years (1872–1891) .	13¼ „	30¼ „	17 „
5 years (1892–1896) .	11½ „	24⅛ „	12⅝ „

These figures show conclusively that even after twenty years of continuous barley growing, the land still felt the effects of the application of dung, discontinued twenty years previously, in the average increase of 12⅝ bushels of barley from 1892 to 1896. Facts and figures such as these led Sir John Lawes to the conclusion that even one hundred years would not entirely efface the effect of previous liberal dressings of dung. These effects would require elaborate calculations, including allowances for interest of money, in order to arrive at their true values; but it is evident that applications of dung are very far-reaching in their consequences, and that practical men are justified in their high appreciation of farmyard manure.

Fat in Stock Foods.—*See* Feeding.

Feeding of Cattle.—This important subject ought to be considered in connection with sheep feeding, as many of the remarks about to be made are equally applicable to both classes of stock; while others serve to point out important practical differences. Just as a knowledge of one language assists in the study of another, or the mastery of one musical instrument helps us to master a second, so a knowledge of the feeding of one class of domesticated animals helps materially in understanding how other classes of animals ought to be fed. Cattle and sheep are closely related to each other. Both are ruminants, and belong to allied genera, Bovis and Ovis.

Their digestive systems are similar, and the foods which are suitable for one are equally suitable for the other. The smaller size of the sheep suggests finer herbage and more concentrated artificial foods. The ox is naturally a straw-eater, and although this is true of sheep, hay is more suitable to their digestive systems. Again, oxen graze upon long grass, while sheep prefer the finer and shorter herbage of the downs. Cattle are identified with the vales and sheep with the hills; cattle are more generally met with upon the deeper and stronger soils of the country, while sheep are identified with the shallower and lighter soils. Grass which will fatten a sheep will not fatten a bullock. Again, cattle require

shelter in winter more than sheep, which thrive even in the severest winters out of doors. Cattle receive, and demand, individual attention, while sheep are counted by the score or the hundred. These peculiarities help us to understand some of the leading differences between the feeding of cattle and sheep, which, in other respects, greatly resemble each other. Similarly, the feeding of either class of animal may be regarded either as natural or highly artificial, according to circumstances. The rancher turns his cattle out, and only mobs them together at intervals for certain purposes. He trusts to grass almost exclusively, or it may be to grass and hay. It is to some extent a matter of indifference to him whether he stocks his land with cattle or with sheep, the choice being made on general considerations as to the class of land and the herbage it produces.

Grazing is a simple matter, although it involves an intimate knowledge of cattle. The successful grazier not only selects a breed suitable for his land and locality, but uses his judgment as to the quality, age, size, and sex of the stock he purchases. He may breed his own stock in preference to buying, and he may be a raiser and seller of young stock, or a producer of beef, according to circumstances.

The subject of grazing cattle is most important, but is eminently practical, especially as regards feeding; and if it is now passed over with brevity, it is not from any desire to underrate its importance. Grass is the natural food of the bullock, and no other food can excel it. The best qualities of beef, milk, butter, and cheese are produced on grass, and of this there can be no doubt. All other systems of feeding are inferior to good grazing, and here, as in many other cases, Nature excels Art.

Artificial Feeding.

The introduction of turnip husbandry was the first step towards the winter fattening of cattle; for previous to that epoch (*circa* 1700) beef was salted down for winter consumption and fresh meat in winter was a rarity.

Turnip husbandry was followed by the improvement of cattle and sheep, and, at a more recent date, by the introduction of oilcake and many other artificial foods.

There are two systems of fattening bullocks. First, what may be called the Scotch and north-country system, in which turnips, including Swedish turnips and straw, are the principal foods used. Secondly, the English or more southern system, in which roots are given in much smaller quantities, pulped or shredded, mixed with cut straw or chop, and intermixed with meals, cakes, and other foods. The first system is comparatively simple, as both turnips and straw are supplied wholly and separately, and the cake and meal are also given at stated times without being incorporated with the bulk in natural foods. It owes its efficacy to the superior quality of both the turnips and straw produced in the cooler and moister climate of the north. That well-fattened bullocks can be produced by turnips and straw has often surprised south-country graziers, who find it necessary to chop their roots and straw into a prepared mass, enriched by cake and meal. Hay is seldom used for cattle feeding in Scotland, but is a staple food in England; and hence the northern system stands out prominently as simple and natural, while the south-country system is complicated and artificial. If winter grazing were always conducted in straw yards, by supplying whole turnips or sliced swedes to the cattle in troughs, and straw in racks, with an allowance of cake once or twice a day, there would not be much to write upon the subject. On the other hand, if chaff-cutting, root-pulping, cake and corn grinding, cooking, and mixing are all assumed to be parts of

a system of feeding, there might easily be more to advance than our present space allows us. The cruder system has no doubt been modified of late years.

The *Transactions of the Highland and Agricultural Society* contain many interesting experiments on cattle feeding, which indicate the growth of scientific methods and a reduction in the quantity of roots given. Still, the number of cattle kept appears to depend upon the acreage of roots grown, which shows that roots are the preponderating food.

The system is commendable for its simplicity and small cost, for turnips are the cheapest food that can be supplied to cattle in a country famous for its heavy root crops. In the south of England the root crops are lighter and the roots much smaller. They are more commonly fed off with sheep on the land, and are often too small for pulling and storing in heaps. Mangel-wurzel takes the place of turnips and swedes, but it is only grown upon a very limited area. The straw is less nutritious in the south than in the north, and less palatable, and requires cutting. The less abundant supply of roots and the lower quality of the straw naturally induces a more artificial system. Pulping roots and chopping straw are economical because they make both go further; but they involve a considerable expenditure of labour and power. As for steaming or cooking food, it must be looked upon as an unnecessary refinement for cattle, although it may be employed with advantage for pigs. Steaming has been recommended as a means of imparting an agreeable flavour to chaff, but it does not assist digestion, and confers no new properties.

Cold water thrown over straw chaff, and well mixed by turning, causes fermentation in a few hours, and produces a similar effect without expense; but neither operation is necessary. Linseed, if first crushed and then boiled into a soup or mucilage, may be thrown over a mass of straw chaff, and mixed with advantage. The straw is rendered more palatable, and this induces the cattle to eat a greater quantity, and the mucilage becomes a means of saving hay. Dry and sweet straw chaff and hay chaff, or both combined, are excellent for mixing with cake and meal; and the mass may be further improved, if pulped roots are incorporated with it, by turning with a shovel on the floor of the mixing-room.

Water is an important item in cattle feeding, and, if possible, should be laid on, so as to be always available. The quantity of roots given to cattle in the system which has been described as Scotch or north country is very great, and frequently amounts to over 1 cwt. per head per day. A bullock will eat much more even than these weights if restricted to roots, and an instance could be quoted in which 250 lb. was supplied per head to working bullocks. It is, however, acknowledged that too heavy a weight of roots is not advisable, and that in no case should more be allowed than sufficient to quench the thirst. When roots are given *ad libitum*, water is scarcely required, although it should be supplied in all cases. When the quantity of roots is limited or reduced to a minimum, water becomes an important element in the dietary. An excess of roots produces laxity of the bowels and purging, shivering at the flanks, and other bad symptoms. The gastric juice is weakened by excess of water, and a good deal of vital force is required to raise it to the natural temperature of the body. Cattle can be fattened without roots, and in the south of England roots cannot be regarded as a cheap food, especially if pulped. The writer has known bullocks fattened on maize meal, straw chaff, with hay and water, and there is no difficulty in fattening them upon chaff, meal, and cake. Turnips, swedes, and mangel all contain nearly 90 per cent. of water, and it is a

question whether this might not in many cases be replaced from the pump.

The value of roots, simply as a source of water, is recognised by sheep-farmers; for carting water is a serious expense, and well got rid of by growing roots. Cattle are in most cases kept in near proximity to water, and, when it is abundant, roots may be dispensed with. Cows in milk and fattening bullocks will do well on straw and hay, cake, meal, dried grains, etc., without roots, although turnips, swedes, and mangel are valued articles of food. As to the quantities of roots given, in some cases 1 to 1½ cwt. are allowed; in others 56 lb., and in others only 20 to 30 lb. When such small amounts are thought sufficient, it is only one step further to dispense with them altogether. They may constitute the staple food, or they may be reduced to a mere adjunct, or lastly, they may be entirely dispensed with. They are, however, accepted as an important item in cattle feeding as ordinarily carried out, and a few remarks must be added upon the comparative merits of different descriptions of roots.

White and yellow turnips are best suited for the earlier stages of fattening, as they are at their best in the autumn. They are frequently thrown about on pastures, in October and November, to accustom bullocks to eat them, before they are brought into winter quarters. They are first given whole, with their tops on. Later, yellow turnips and swedes take the place of white turnips, and these require slicing or pulping. When sliced, they are given as a separate feed, after dry food in the forms of meal and chaff. Swedes are at their best from December to March inclusive, but in April and May they are liable to become dry or stringy. Mangels succeed swedes, and may be used with advantage late into summer. They increase in value as swedes lose their feeding properties, although they are scarcely equal to swedes in winter. Next, as to the dry and "artificial" foods; the "chaff" may be of hay or straw, or a combination of both. The best quality of linseed cake and barley-meal are among the most popular and best of the concentrated foods, but there are many others available on the market. Among them may be mentioned decorticated cotton cake, which is less digestible than linseed cake, and is better given mixed with it in the proportion of half-and-half. Locust beans are a very excellent food, and so are rice meal, maize, bean, pea, and oat meals; pollards, wheat-meal, if given in small quantities; and it is best ground up with barley, oats, and maize in equal proportions. Treacle, diluted with water, is often employed to throw over chaff; and malt is occasionally used, as are also special spiced foods for cattle preparing for exhibition (*see* Condiments in Foods). There are many "compound" cakes, which it would be invidious to name, but which are familiar to all feeders, and highly esteemed by many. Concentrated foods may be selected upon chemical or physiological grounds, but oftener they are purchased according to the fluctuations of prices, which are very considerable. Highly nitrogenous foods, such as the various natural cakes, beans, peas, and malt culms, are rich in albuminoids, and confer a special value on the manure produced. For fattening purposes the amylaceous or farinaceous elements should be united with the albuminoid constituents in order to at once promote the accumulation of fat and repair the natural waste of the body. The "life-tax," *i.e.* the maintenance of the heat, strength, and vital functions of the body, must be paid, before there can be any increase in weight; and hence it is evident that feeding must be liberal, and in excess of the requirements of the animal frame. On the other hand, cattle are easily "surfeited," and good management consists in observing the mean between under- and over-feeding. An excess of albuminoids beyond the requirements of waste

and growth, either acts injuriously upon the system, or is passed through the bowels, or excreted by the kidneys. It is recovered in the manure it is true, but at too great a cost, and there is no advantage in excessive cake-feeding. The principal points to be observed in feeding bullocks are—(1) Regularity, (2) cleanliness, (3) a well-proportioned diet. The animals must be comfortable and contented, and do best in small yards furnished with ample shedding, so that they can stand out in the sunlight, or enjoy the rain, or take shelter, as they choose. The conservation of the manurial residues is so important that every means should be taken to avoid waste through exposure to the weather; but small yards with spouted sheds combine the best conditions for both the cattle and the manure (*see* Farmyard Manure).

Daily Routine of Feeding Bullocks.

Fattening cattle should be attended to early in the morning, and receive their last food at 8 o'clock at night. If tied up in stalls, they require to be kept clean, and in some cases they are brushed and groomed, but this is not usual. When kept in loose boxes, or in small yards, this requirement is not necessary. A good herdsman will give his cattle their first feed not later than 5.30 in the morning, and this may consist of meal mixed with cut chaff, and just enough pulped roots to moisten the mass. At 7.30 to 8 he will give them, say, 20 lb. of sliced swedes, and at 9.30 meal, chaff, and pulped roots as before. At 12 o'clock they should have their cake, alone or with a little chaff; at 2 and at 4, meal and chaff, and at 6 to 8 o'clock an allowance of long hay. The frequency of their meals may be curtailed, but the principle is sound, and it is much better that cattle should clean up what is given them than that they should stand over stale food.

As to the quantities of concentrated food and of food generally, suitable for fattening cattle, considerable latitude is allowed. One food at least should be given *ad libitum*, and that of a bulky description, such as straw or roots. The animal *must* be satisfied, although we may limit the quantities of some of the foods employed. A rack full of sweet oat straw or hay will serve the purpose of keeping the animal from feeling dissatisfied, and the allowance of concentrated food should be progressive, according to the size of the bullock. About 3 or 4 lb. of mixed cake and meal is enough for a beginning, and these amounts should be increased at intervals of a fortnight, by about 1 lb. of each class of food. In some cases lavish quantities are given, but a maximum of 6 or 7 lb. of cake, and 6 or 7 lb. of barley-meal or other similar foods, ought to be sufficient for most fattening bullocks. It is usual to "push" bullocks as they approach ripeness, and the quantity of food is often left to the discretion of the herdsman. It is easy to see if they are doing well by the appearance of their coats, the touch of their skins, and their good appetite and placid deportment. A great deal of the success of feeding depends upon close attention, and it has been aptly said that "the eye of the master grazeth the ox." The care and good judgment of the "man" is equally important with the attention of the master.

Feeding according to Sex and Age.

The above remarks on feeding are especially applicable to fattening cattle, and are not in every respect suitable to other classes of horned stock. Cows in milk, and, as is generally the case, in calf, require a larger proportion of albuminous food than mature steers. The cases of cows and young stock are in certain respects parallel, for both are developing new tissues such as bone, muscle, organs, brains, and nerves. Milk is a constant drain upon a cow, because it contains all the ingredients of bone and other

tissues. Cows ought therefore to be fed with abundance of nitrogenous foods, such as cotton-cake, bean-meal, dried grains, malt-culms, and clover-hay. Dry cows will do well in "straw-yard" with an allowance of 3 lb. of rough cotton cake. Calves do best on new milk, but milk substitutes may be used with advantage, unless the animal is intended for veal, in which case new milk is the most suitable food. Weaning calves and young stirks should have 1 or 2 lb. linseed cake, with hay or grass, according to the time of year; and yearling and two-year-old cattle can be maintained in good growing condition on straw and 3 or 4 lb. of mixed cakes.

The purpose for which animals are intended should always be kept in view. In some cases they are fattened from birth, and never allowed to lose their calf flesh. In other cases they will be required to rough it upon ordinary grazing, until two to two and a half years old, and then to be sold as stores, or as in-calf heifers. When intended for such purposes, all pampering should be avoided, and the animals should be kept in good store condition only, and as much in the open air as possible.

Feeding of Horses.—In the following remarks the subject will be treated practically, and, as it were, in answer to the question, How should I feed my horses? The answer to this important question naturally leads to the rejoinder, What description of horses do you keep? It is evident that a sufficient answer to the first inquiry must include a knowledge as to the second; and hence it is necessary to divide the subject into the following headings:

1. The feeding of foals and young horses.
2. „ „ „ mares in foal.
3. „ „ „ agricultural horses.
4. „ „ „ nag horses.

These divisions of the subject might be increased in number; for instance, the best method of feeding horses required for fast work, such as hunting or racing; for exhibition and sale; for waggon and pit work, in towns and collieries, etc. It is, however, the intention in this article to treat the subject as it presents itself to farmers who work and breed horses, and with this end in view the above four divisions will meet the case. The feeding of growing horses, working horses, and brood mares include all that a farmer wishes to know, but a few remarks upon the feeding of nag horses and hunters will be interesting to many readers. To properly understand the *rationale* of horse feeding, some appreciation of the digestive system of the horse is necessary. Proper food and judicious feeding sum up the entire matter; and it is not too much to say that both are fairly understood by experienced masters and good men.

The digestive system of the horse differs from that of ruminants in that the horse is furnished with one stomach of comparatively small size, which receives the food direct from the gullet, and subjects it to the action of the gastric juice before it is passed on to the small intestine. The stomach of the horse is a mere enlargement of the alimentary tube. Near the intestinal opening is a lesser pouch called the *antrum pylori*, because it abuts upon a strong muscular ring called pylorus, which guards the entrance to the small intestine. The inner lining of the stomach in the horse is divided into two principal parts: the left or cardiac half consisting of a tough protecting coat which secretes no solvent fluid, and is very strong and folded on itself. The lining on the right side only is capable of secreting

gastric juice. The horse's stomach is small, with a capacity of 14 or 15 quarts, and a horse dying of repletion of the stomach has not more than 20 to 30 lb. weight of food in it. Horses rarely vomit, not on account of a sphincter muscle at the low end of the œsophagus, which really does not exist, but on account of the mechanical obstruction of the folded internal membrane at the cardiac opening which offers an impediment to regurgitation, unless the stomach is inordinately distended, or has suffered injury, or unless the œsophagus is morbidly dilated. The three causes of vomiting in the horse are distension, including the antrum pylori, rupture of the organ, and dilatation of the œsophagus. By accustoming the animal to bulky soft food the stomach becomes very large and thin, and this fact is of importance in the selection of foods. Impaction of the stomach is a common ailment among horses, and results in stomach staggers. This disease occurs as an epidemic in wet seasons, especially in the hay-making season, but is frequently due to injudicious feeding. Whole wheat, even in small quantity, will induce a firm impaction, which usually proves fatal. Even wheat flour is liable to produce colic, and this grain in any form, or unless given in very small quantity, is liable to produce gastric derangement. Keeping horses long without food induces ravenous feeding, and may easily result in stomach staggers through impaction.

Colic is caused by over-feeding, bad and irregular feeding, and overwork. It is a spasmodic affection of the intestine, and is never inflammatory (Gamgee). It is due to interferences, through some cause, with the regular peristaltic movement of the intestine, and is intimately connected with errors in diet. It is accompanied with severe spasmodic pain, and usually gives way to treatment within a short time, but is occasionally fatal. When death occurs the intestine is found loaded and obstructed with fæcal matter, or a calculus is found. Sometimes the large intestine, especially the colon, is ruptured, and the contents thrown into the cavity of the peritoneum. The immediate cause of colic is not inflammation, neither is it liable, as many think, to run into inflammation. It is due to a disturbance of the healthy action of the intestine, and this points at once to errors in diet as the principal cause. It is therefore important to consider the errors which may tend to fatal results, and among them must be included long fasting, as, for example, when horses are taken from the stable to the field at 7 a.m. and return at 4 p.m. without a bait. Long yokings should always be broken at midday, in order that the horses may be fed and watered; and if water is not available, as is sometimes the case, pulped swedes or mangel should be mixed with the chaff and corn. Straw, if given without the addition of swedes, turnips, or mangels, is liable to produce colic. Straw may be used with economy and advantage in feeding working horses, but should always be associated with roots, bran mashes, or some form of soft food. Professor Gamgee, in his treatise on *Our Domesticated Animals in Health and Disease*, wrote of "the abominable boiled-meat system," in connection with colic; but hard feeding, especially when horses are newly taken up from grass, is a frequent cause of this malady, which is best avoided by the use of roots, green fodder, and mashes at intervals, say twice a week. The writer has systematically introduced swedes and mangel into his work horses' diet, and has not had a single case of colic for several years, although he feeds with straw, to the exclusion of hay. Millers' horses are said to be particularly subject to colic and calculus, caused by too free a use of pollards and of mill products unsuitable for the digestive system of the horse. Injudicious watering is often to blame, especially copious draughts of cold water, when the animal is in an exhausted condition. Parasites in the

intestine and other causes, outside mere feeding, will cause colic; but judicious feeding will reduce these attacks to a minimum. Laminitis or inflammation of the feet often follows impaction of the stomach, and is caused by bad feeding; and, without entering upon the subject of diseases generally, it is important to emphasise the fact that proper feeding is the best safeguard to health.

In what has already been advanced, some of the commonest errors of feeding have been pointed out, and it remains for us to consider the best methods of feeding consistent with perfect health. To be as brief as possible, oats and hay must be regarded as the staple foods. Both are adapted for the digestive system of the horse in a high degree, and are very difficult to beat. Especially in the case of horses used for fast work like hunters, or for long journeys like roadsters, the best old oats and the finest hay may be recommended. Dry or old beans have always been regarded with the greatest favour by others who know their work, and all that is required is to limit the quantities supplied, and regulate the hours of feeding.

Economy is of importance in the feeding of draught horses, and leads us to consider cheaper foods than the best qualities of hay, oats, and beans; and among the substitutes which may be employed straw naturally occupies an important place. It may be given in the form of chop or cut straw; wheat-chaff—a very valuable adjunct in a farm stable—or long straw. To mix corn with straw-chaff or "doust" (wheat-chaff) before placing it in the manger is a common and excellent practice, and the racks are then filled with oat or barley straw. Two bushels of oats per head per week thus given, with straw *ad libitum*, is quite enough food for a full-sized farm horse on ordinary work. On farms, the oats reserved for the horses are not of the heaviest and best quality, although it is usual in treatises on horse feeding to insist on both. It is, however, scarcely likely that a farmer will keep his best oats for his work horses, but rather use those less saleable oats weighing 37 to 39 lb. per bushel. Barley straw is less nutritious than oat straw, unless it contains a proportion of clover, as it often does. As to the popular objection that barley straw "breeds" lice, such visitations more probably arise from poverty of blood due to poor feeding than from the use of barley straw itself. Wheat straw can only be used after chaff-cutting, but when so treated may be employed for mixing with the corn. Maize may be recommended without hesitation, especially when it is cheaper than oats. It is said to produce "grease," but after many years of experience, the writer has found 1½ bushel of maize per week, with straw and roots, a sufficient dietary for farm horses. As maize can always be procured dry and sound at prices slightly above or below 3s. per bushel, the above quantity per week certainly is an economical feed, and the straw scarcely counts upon a farm as an appreciable cost. Space forbids a multiplication of dietaries suitable for farm horses, for their name is literally legion. In Scotland 3½ bushels of oats and hay *ad libitum* has been often thought requisite for Clydesdale horses at hard work, but such a diet seems needlessly expensive, especially when hay is dear. Similarly 3 bushels of oats, ½ bushel of beans, and best hay *ad libitum* is recommended for contractors' horses doing severe work; but farm horses rarely are out more than nine to ten hours, and their work is steady and liable to interruptions. Considerable saving may be effected by manger-feeding in preference to the system of giving long hay in racks. A reasonable allowance would consist of 1¾ bushel of oats, ¼ bushel of beans, 1 bushel of brewers' grains per week, with about 20 lb. of cut straw per day.

The feeding of farm horses varies with the seasons, which may be conveniently divided into two—*i.e.* from Michaelmas to mid-May, when the feeding just mentioned will be ample; and from mid-May to Michaelmas, when the horses will probably be turned out at night, receive cut clover, vetches, and other green fodder, and 1 bushel of oats per week. The advisability of turning out is open to doubt, and many good farmers prefer "soiling" in yards. Over wide districts, however, the system of summer grazing is practised, and the horses appear to enjoy the freedom it affords.

The feeding of foals and young horses requires a few words. Foals are dropped in spring, and should be turned out with their dams on grass land if, or as soon as the weather is suitable. Up to Michaelmas, when they are weaned, they live on milk and grass. After weaning, they are still kept out of doors, although a shed or hovel should be provided, and from 1 to 2 pecks ($\frac{1}{2}$ bushel) of oats per week will be sufficient with good sweet hay when the grass is short. They need no corn during their second summer, but should receive from 2 to 3 pecks of oats the second winter, with grass and hay in hard weather. Carrots and a few roots may also be given. Mares in foal are usually treated precisely in the same manner as the rest of the team, but require care, and in some cases a little extra indulgence both as regards work and food, especially before and after foaling.

The times of feeding and quantities of food given per feed or per diem are equally important with the weekly allowance. Horses are slow feeders, and ought to have their first feed not later than 4.30 a.m. if they are to leave the stable at 6. In some localities the carter or head ploughman appears at 4 a.m. or even earlier, and feeds his horses sparingly with small quantities for a considerable time. Another feed is given at midday, and a third at 5 to 6 p.m. They are then left till foddering or suppering time at 8 p.m., when they are again fed, and the racks filled with straw or hay, as the case may be. A feed of oats weighs 3 lb., and four feeds a day equals 12 lb. of oats or 2 bushels per week of 42 lb. each. One 56 lb. truss of hay per week or 8 lb. per day is also thought sufficient, but all animals should have the opportunity of satisfying their appetites, and it is therefore desirable to rack up with oat straw during the night.

The feeding of nag horses, roadsters, or hunters differs from that of farm horses in the more concentrated character and higher quality of the food. Old oats are preferred, and hay free from mould or dust. Beans of old and dry character are also given, split or quartered, in moderate quantities. Such horses are fed in accordance with the work before them, and a hunting horse should not be sent out with a full stomach, but be fed for his work on the previous day, and with judgment. Similarly, watering must be regulated by the demands to be made upon the animal. Such matters are carefully attended to by good stablemen, who ought to be informed on the previous day what is to be required of their animals. The injudicious use of green food is, or may be, dangerous to horses about to do fast work, and for such horses dry feeding is to be preferred. At the same time there are few grooms or coachmen who do not appreciate carrots, bran, or linseed as useful helps in bringing horses into condition. Farm horses may be fat, but horses intended for quick work should be muscular and "hard." The question of horse feeding may be discussed upon physiological grounds, which would entail the consideration of the digestion co-efficient or relative digestive power of the horse in comparison with ruminants and other animals as exercised on particular foods. Also the relations of the food consumed to work performed—(1) in keeping up the heat of the body and in performing the digestive functions; (2) in external work. Thus it has

been shown that in the digestive system of the horse so much extra force is expended in the digestion of straw as to exhaust all the nutritive properties of that article of diet. Such questions are highly interesting scientifically, but are often overruled in practice by pecuniary considerations or convenience; and they may therefore be left for the further study of physiologists, and as yet scarcely bear on the practical question of horse feeding.

Feeding of Sheep.—No pursuit is fuller of classical associations than the tending of sheep. In calling to mind the earlier accounts of the care and solicitude of the shepherds in leading their flocks to new pastures, or by the side of still waters, much is at once seen to be applicable to the requirements of sheep in our own day. The migrations of the flocks, according to the abundance of the herbage, and the striving of the herdsmen of Abraham and Lot for the mastery of wells and springs, illustrate features of colonial and hill sheep farming at the present day. The subject, from this point of view, is comparatively simple, and is associated with abundance of leisure, but at the same time with unremitting watchfulness; for the ancient shepherds "watched their flocks by night" as well as by day. If we turn from these extremely early descriptions of sheep feeding to our own times and our own methods, we shall find much in common; for the same careful attention to each individual of the flock, the same constant watchfulness and care, both as to food and water, mark the modern shepherd. Those who practise sheep farming on the Highland walks, or on the broad expanses of Cheviot, can best appreciate the link which binds the present to the past. Feeding is, of course, only one item, and it is not for us to go beyond it at present; but it is necessary to lay stress upon the importance of judicious changes of food, and the dangers of unsuitable situations and herbage. A single day upon boggy land, at certain seasons of the year, may cause wholesale loss from "rot"; and too long a sojourn upon luxuriant grass may easily be fatal to some members of the flock. Shepherding is a craft or "mystery," a hereditary calling, handed down through generations, and less dependent upon science than upon practice. Considering the subject as a pastoral occupation, rather than as an adjunct of arable farming, it does not lend itself to scientific treatment so much as to inherent and instinctive knowledge. To run sheep on grass land may appear a very simple matter, but even this requires care, in the adaptation of the class of sheep maintained to the land, and in the regulation of changes from pasture to pasture. When, however, we turn from the simpler task of the pastoral farmer to the more complicated management of sheep upon arable land, we find ourselves confronted with an artificial system of feeding, dependent upon turnip cultivation, and the employment of a large assortment of "artificial" foods. Even in summer the arable land farmer does not trust to grass alone, but folds his sheep upon fodder crops, such as green rye, trifolium, clover, vetches, and rape.

Sheep Feeding upon Arable Land.

The degree of complication varies according to circumstances. The management may include either ewes and lambs, teg fattening or lamb fattening; it may be restricted to the raising of stock lambs only, or to keeping a dry flock of fattening sheep, bought in every autumn and sold off every spring. The subject is best considered as a department of mixed farming, in which a flock of moderate size is maintained, and the lambs

are kept on the place until they are disposed of at ten to eighteen months old as mutton. By this treatment of the subject we shall be able to divide it as follows: (1) ewe feeding, (2) lamb feeding, (3) teg fattening; while the fattening of lambs may be treated as an intermediate matter.

Before entering upon the details of each of these sections, it may be observed that sheep are usually kept upon the higher and drier descriptions of soil. Sheep land is customarily regarded as of light and friable character, and it is found in the greatest perfection upon the chalk hills which occur in no fewer than seventeen English counties. Also upon the oolitic limestone soils, which extend from Yorkshire in the north-east to Dorset in the south-west; on the magnesian and mountain limestone, the sandy soils of the green sand, the loams of the New and the Old Red Sandstone, the alluvial soils of East Anglia, and, in a word, wherever the land is suitable for winter folding. In the southern counties of Hants, Wilts, Berks, Dorset, and contiguous counties, a system of catch-cropping prevails, which enables the farmers to keep heavier flocks of sheep during summer than in winter; and it is in these districts that large ewe flocks are maintained which, naturally, double the head of sheep stock in summer. The lambs are not sold until autumn, and, consequently, 700 sheep, including ewes and ewe tegs, during winter, swell into 1200 or 1300 sheep and lambs during half the year.

In order to provide food for this stock a large area of autumn-sown fodder crops is provided to afford a reserve of food. In order, to be brief, these crops can only be mentioned in the order in which they are fit for consumption, and are as follows: (1) winter rye, (2) winter barley, (3) trifolium incarnatum, (4) vetches, (5) rape, (6) cabbage, (7) early turnips. These crops are all folded upon the lands, and the folds are immediately broken up, dressed, and drilled with mangel, rape, swedes, and turnips; and by this system the flock is provided with succulent fodder for the entire year. Clover and sainfoin hay is also made in large quantities, and provides dry fodder, while, on the best managed farms, cakes, beans, and other purchased foods are fed in very large quantities. Such is the general provision made for a large flock of ewes with their lambs, and we shall now enter upon some of the principal details of feeding, according to sex and age. It will not, however, be necessary to confine the remarks now to be offered entirely to the above systems of farming, but rather to deal with each section so as to fairly indicate the best methods.

Ewe feeding.—Ewes are adapted for the poorer classes of land, as it is not desirable for them to be fat, but only in fair store condition. Where the land is of such quality as to fatten the ewes, they are often sold in order to make room for fresh purchases every season; and this is termed a "flying" flock, in contradistinction to a permanent flock. Ewes may be kept "hard," provided that they are kept healthy, and this being the case, they are often used to follow, or clear up, after sale sheep. For example, when fattening or sale lambs are on rape or cabbage, the ewes follow and clear up after them. During the fourteen or fifteen weeks in which they are suckling lambs, the ewes participate in the more generous diet of their offspring; but after weaning, they are often employed as a means of preventing waste, in consuming what is left by the more richly fed sections of the flock. In this system of feeding, preference is given to the young or two-teeth ewes, which are still growing, while the six-teeth and full-mouthed ewes are made to subsist on less nutritious food. Another exception is made in the case of the draft or over-year ewes, which are better treated in order to make them fit for market. The year is, in fact,

divided into different periods, during each of which the food of the stock ewes varies—(1) A period of good keep during the time in which they have lambs with them; (2) a period of harder keep, as above indicated, with runs upon open downs or poor pasturage; (3) a brief period of better keep for the month or six weeks during which the rams are turned out; (4) a resumption of poor or moderate keeping until within a month of lambing; (5) rather better keep before lambing. Grass is the most suitable food for ewes, whether in the form of downs, parks, pastures, old seeds, or aftermaths; and from the time the lambs are weaned, forward to the next lambing time. The monotony of simple grazing is broken on arable farms by excursions into fodder crops to clear up after lambs, roaming over stubbles after harvest, a bait of turnips or mustard while they are with the rams, and a liberal allowance of hay in and after October, when the usual rains and hoar-frosts begin to occur. Oat and pea straw take the place of hay in some localities, but plenty of dry food and a moderate use of roots, conjointly with a firm and dry lair, are cardinal points in ewe management.

The flock (by which is usually meant the ewes) should live as much as possible upon the natural produce of the farm, and cake or corn is given for the sake of the lambs rather than for the dams. Such artificial foods may be given at the rate of about half a pound per head shortly before lambing, if the ewes are poor, to promote the flow of milk, and after lambing, for the same reason. Many flockmasters discriminate between ewes with single lambs and ewes with twins, or between ewes with ewe lambs and those with wether lambs or ram lambs, or, again, between four-teeth ewes and the older sections of the flock. Cake for ewes is discontinued at weaning time, or it may be continued to shearing time, on account of the wool coming off easier and better under the shears if the ewes are not deprived of their cake.

Lamb feeding varies with the object in view. Lambs intended for rams or for fattening, either as lambs or as ten-month-old wethers, are "done" well from birth, and receive food in troughs when a fortnight old. This consists of finely ground linseed cake, split peas, and quartered old beans, to which may be added coarsely ground maize and even a little malt. They are allowed to run forward before the ewes, through creeps or lamb-hurdles, and their troughs are arranged outside the fold. If we take as a standard the management of lambs on those chalk soils where they attain a value, as wethers, of 50s. to 60s. each in August or September, their food is of very varied character from their birth in January. Immediately they leave the lambing pen, they are folded on white turnips or swedes, and run forward through the creeps, in order to crop the turnip greens and receive their trough food. Their dams are "caked" liberally, and kept between hurdles on roots and hay. As the season opens, they are placed on green rye, and later and successively on winter barley, trifolium, and vetches, which bring them up to July, when rape, clover-aftermath, and cabbages, or early turnips conclude the season. They are allowed two or more changes of natural food daily, as, for example, swedes or mangel, with rye, winter barley, or trifolium; and, later in the season, vetches with rape, and a run over clover-aftermath. The mixture of artificial foods, which begins with a mere sprinkling in the troughs, is gradually increased for the lambs, and taken off the ewes. It may average 1 lb. per head, *i.e.* 1 lb. to the ewes, and by weaning time the amount is completely transferred to the lambs. Such lambs as we are considering will receive during their final weeks from 1½ to 2 lb. of cake and corn per day, and mangel is often made to last throughout the entire period. The life of one of these lambs during July and early August will begin in the early morning with cut

mangels, placed in troughs, after which they will receive an allowance of cake and corn. They then go into rape, and in the heat of the day they are allowed to spread over clover-aftermath. Towards evening they receive a second feed of cake and corn, and then return to a fresh fold of vetches. Under such treatment they grow very rapidly, and the writer has known Hampshire-Down lambs increase in live weight at the rate of 1 lb. per day.

The highly artificial and forcing system just described is carried on in the south of England, but hardly gives an idea of lamb feeding as carried out in the northern counties or Scotland. There the system is more natural and slower. The lambs are dropped several weeks later, and are run with their dams on young "seeds" or other pastures. The usual corn is oats, and they often live entirely on grass after they are weaned. In such cases the art of feeding principally consists in changing from pasture to pasture and in general and daily care, requiring no particular description.

Teg fattening.—Over large areas, dry flocks take the place of lamb breeding. As before stated, ewes are generally kept upon the poorer and higher classes of land, while tegs are fattened upon soils of better quality. The occupation may be carried on in summer or winter. In the former case the lambs will be over a year old, and are kept on grass and fed with oats, cake, and other descriptions of food. They are shorn, and drafted to market, as they become fit. Where winter-fattening is practised, the lambs change hands at the autumn fairs, and are transferred to districts fitted for the purpose, usually on to land of a heavier and flatter character. There they are placed upon rape, turnips, and other autumn fodder, until they find themselves on swedes and full winter's keep. In the early part of the season they break their own turnips, but swedes are harder than turnips, and besides this, the central incisor teeth begin to loosen previous to their replacement by permanent incisors; and this renders it advisable to cut the swedes into finger-pieces with a turnip-cutter. After the preliminary weeks during which they may be allowed a daily run on grass with a tie or fold of turnips, and a small allowance of corn, they are entirely confined between hurdles, or nets, on swedes, and receive an increasing quantity of cake, corn, and hay. The amount of artificial food (exclusive of hay) commences with $\frac{1}{4}$ lb. per head per day, and is increased to $\frac{1}{2}$ lb., to $\frac{3}{4}$, and 1 lb., which is a fair maximum. In such cases, one lot of tegs will be fattened off during winter, and will be sold out when the roots are all eaten. In other cases, lambs in forward condition are purchased at higher prices, and are fattened off by January or February; and a second lot is bought in, and rapidly pushed forward for sale before or after shearing. There is no object in prolonging the process, and liberal treatment and quick fattening is thought by many good farmers to be up to date, and more profitable than a more leisurely system. Two lb. per head per day of cake and corn is always thought exceptionally hard feeding, and is as much as a sheep will consume. One lb. of cake, 1 lb. of clover hay, and 20 lb. of swedes may be considered as a typical dietary for a fattening sheep, but it is difficult to lay down any hard-and-fast rule. The pitting and cutting of swedes into troughs and regular feeding are principal points in fattening sheep during winter.

Foods most suitable for Sheep.

This short article is necessarily general in its scope, but it would be still more imperfect without a few remarks upon the foods most suitable for sheep. The digestive system of these animals is in many respects similar to that of cattle and other ruminants. Like all species of this class, they

require bulky food, but sheep need a more concentrated diet than cattle. Straw is not so well adapted for sheep as for bullocks, and their power of assimilating hay points to the advisability of supplying it in preference to coarser fodder. Sheep do best on sweet young herbage, while cattle can thrive on older and longer grass. Similarly, sheep do best on the finer descriptions of fodder, such as trefoil and clover hay, rather than on rye-grass hay. They do well on turnips and swedes, and in the later spring may be allowed mangel-wurzel. Such forage crops as have been already named are also excellent sheep keep. Turning to the question of artificial foods, the most suitable for sheep are finely crushed linseed cake, old beans, and peas, both the latter being griddled or split. Maize in moderate quantities may be added, and oats, over large districts, are looked upon as a standard food for sheep. With regard to cotton cake, it is best given in the decorticated form, but ewes and tegs will also do well upon the undecorticated cake. A mixed diet is always to be preferred, and the choice of both cakes and corn will be regulated in a great measure by prices. Many elaborate experiments have been conducted upon sheep feeding at Rothamsted, Woburn, and on many of the State-aided agricultural college farms, but these rather endorse the practice of the best sheep farmers than throw any new light upon the subject. As is well known, and thoroughly appreciated by farmers, the advantage of feeding sheep lies quite as much in the improvement of the land as in direct profit. It could be shown that after deducting the price paid for lambs, and all the attendant expenses of root cultivation, artificial foods, hay, and shepherding, there is little actual profit left to the producer of mutton. The effect upon the soil is, however, very great, and after the sheep have passed over the land, heavy crops of barley, oats, clover, and wheat can be grown. It is principally for this reason that sheep are regarded as the "sheet anchor" of light land farming.

Feeding Stuffs, Analytical and Manurial Values of.—It was a happy idea which led Sir John Lawes and his life-long co-worker Sir Henry Gilbert to draft a table showing the Analytical and Manurial Values of all the standard feeding stuffs. Many "scales" of compensation values for feeding stuffs had been prepared by Farmers' Clubs and Agricultural Associations throughout the country; but these "scales" of compensation values for feeding stuffs differed widely from each other, so that they were more or less empirical. But a "scale" drawn up by the world-famed scientists of the Rothamsted Experimental Station was a scale which no one could ignore, and served to show clearly what science had to say as to the feeding and manurial value of these feeding stuffs, and the rate of exhaustion when their residual produce was returned to the soil. Four years later, when the Agricultural Holdings Act of 1900 came into operation, and led farmers, land agents, and proprietors to look closely into the question of residual values and rates of exhaustion, the "scale" originally drawn up by Sir John Lawes and Sir Henry Gilbert was carefully revised by Mr. A. D. Hall, Director of the Rothamsted Station, and Dr. Voelcker, Chemical Adviser to the Royal Agricultural Society of England. It was then published by the Royal Agricultural Society, and has since then been the "scale" generally recognised and adopted by arbitrators under the Agricultural Holdings Acts. It is quite true of course that the analytical and manurial values set forth in the "scale" are those of typical or average qualities of the various feeding stuffs, for feeding cakes

vary in composition according to the original quality of the seed and the amount of pressure applied in extracting the oil, while home-grown produce

TABLE SHOWING THE COMPOSITION, MANURIAL,

(REVISED FROM LAWES AND

By MR. A. D. HALL, *Director of Rothamsted Station;*

FOODS.	Valuation per Ton					
	Nitrogen.			Phosphoric Acid.		
	Per Cent. in Food.	Value at 12s. per Unit.	Half of Value to Manure	Per Cent. in Food.	Value at 3s. per Unit.	Three-quarters of Value to Manure.
	Per Cent.	*s. d.*	*s. d.*	Per Cent.	*s. d.*	*s. d.*
1. Decorticated Cotton Cake .	6·90	82 10	41 5	3·10	9 4	7 0
2. Undecorticated Cotton Cake.	3·54	42 6	21 3	2·00	6 0	4 6
3. Linseed Cake . . .	4·75	57 0	28 6	2·00	6 0	4 6
4. Linseed	3·60	43 2	21 7	1·54	4 7	3 5
5. Palm-nut Cake . . .	2·50	30 0	15 0	1·20	3 7	2 8
6. Cocoa-nut Cake . . .	3·40	40 10	20 5	1·40	4 2	3 1
7. Rape Cake	4·90	58 10	29 5	2·50	7 6	5 8
8. Beans	4·00	48 0	24 0	1·10	3 4	2 6
9. Peas	3·60	43 2	21 7	0·85	2 7	1 11
10. Wheat.	1·80	21 7	10 9	0·85	2 7	2 0
11. Barley.	1·65	19 10	9 11	0·75	2 3	1 8
12. Oats	2·00	24 0	12 0	0·60	1 10	1 5
13. Maize	1·70	20 5	10 2	0·60	1 9	1 4
14. Rice Meal	1·90	22 10	11 5	0·60	1 9	1 4
15. Locust Beans . . .	1·20	14 5	7 2	0·80	2 5	1 10
16. Malt	1·82	21 10	10 11	0·80	2 5	1 10
17. Malt Culms	3·90	46 10	23 5	2·00	6 0	4 6
18. Bran	2·50	30 0	15 0	3·60	10 10	8 2
19. Brewers' Grains (dried) .	3·30	39 7	19 9	1·61	4 10	3 8
20. Brewers' Grains (wet) . .	0·81	9 9	4 11	0·42	1 3	0 11
21. Clover Hay	2·40	28 10	14 5	0·57	1 9	1 4
22. Meadow Hay . . .	1·50	18 0	9 0	0·40	1 2	0 11
23. Wheat Straw . . .	0·45	5 5	2 8	0·24	0 9	0 7
24. Barley Straw . . .	0·40	4 10	2 5	0·18	0 6	0 4
25. Oat Straw	0·50	6 0	3 0	0·24	0 9	0 7
26. Mangels	0·22	2 8	1 4	0·07	0 3	0 2
27. Swedes	0·25	3 0	1 6	0·06	0 2	0 1
28. Turnips	0·18	2 2	1 1	0·05	0 2	0 1

will vary considerably through many causes which are well known. The following is the revised table in question:—

AND COMPENSATION VALUES OF FEEDING STUFFS

GILBERT'S TABLES, 1897).

and Dr. VOELCKER, *Chemical Adviser to R.A.S.E.*

AS MANURE.		Compensation Value for each Ton of the Food consumed.				
Potash.						FOODS.
Per Cent. in Food.	Value at 4s. per Unit, all to Manure.	Last Year.	Second Year.	Third Year.	Fourth Year.	
Per Cent.	s. d.	s. d.	s. d.	s. d.	s. d.	
2·00	8 0	56 5	28 2	14 1	7 0	1. Decorticated Cotton Cake.
2·00	8 0	33 9	16 10	8 5	4 2	2. Undecorticated Cotton Cake.
1·40	5 7	38 7	19 3	9 7	4 9	3. Linseed Cake.
1·37	5 6	30 6	15 0	7 7	3 9	4. Linseed.
0·50	2 0	19 8	9 10	4 11	2 5	5. Palm-nut Cake.
2·00	8 0	31 6	15 9	7 10	3 11	6. Cocoa-nut Cake.
1·50	6 0	41 1	20 6	10 3	5 1	7. Rape Cake.
1·30	5 2	31 8	15 10	7 11	3 11	8. Beans.
0·96	3 10	27 4	13 8	6 10	3 5	9. Peas.
0·53	2 1	14 10	7 5	3 8	1 10	10. Wheat.
0·55	2 2	13 9	6 10	3 5	1 8	11. Barley.
0·50	2 0	15 5	7 8	3 10	1 11	12. Oats.
0·37	1 6	13 0	6 6	3 3	1 7	13. Maize.
0·37	1 6	14 3	7 1	3 6	1 9	14. Rice Meal.
0·80	3 2	12 2	6 1	3 0	1 6	15. Locust Beans.
0·60	2 5	15 2	7 7	3 9	1 10	16. Malt.
2·00	8 0	35 11	17 11	8 11	4 5	17. Malt Culms.
1·45	5 9	28 11	14 5	7 2	3 7	18. Bran.
0·20	0 10	24 3	12 1	6 0	3 0	19. Brewers' Grains (dried).
0·05	0 2	6 0	3 0	1 6	0 9	20. Brewers' Grains (wet).
1·50	6 0	21 9	10 10	5 5	2 8	21. Clover Hay.
1·60	6 5	16 4	8 2	4 1	2 0	22. Meadow Hay.
0·80	3 2	6 5	3 2	1 7	0 9	23. Wheat Straw.
1·00	4 0	6 9	3 4	1 8	0 10	24. Barley Straw.
1·00	4 0	7 7	3 9	1 10	0 11	25. Oat Straw.
0·40	1 7	3 1	1 6	0 9	0 4	26. Mangels.
0·22	0 11	2 6	1 3	0 7	0 3	27. Swedes.
0·30	1 2	2 4	1 2	0 7	0 3	28. Turnips.

Fen Lands.—These soils are to a great extent confined to East Anglia, and are associated with the fens of Lincolnshire, Cambridgeshire, Huntingdon, Northampton, and Norfolk. This vast tract is for the most part continuous, and is traversed by the Great Northern Railway from Peterborough to Doncaster. It crosses the Humber, and forms the flat lands of Holderness, and extends into Nottinghamshire, forming a tract known as the "Carrs." The Isle of Axholme rises out of and divides the dead level by a ridge running north and south, conspicuous to the eye.

The most northern limits of the fen and marsh (expressions which denote two distinct classes of land) are to be seen from the chalk hills of Beverley, southwards and eastwards over Holderness and North Lincoln, divided by the wide estuary of the Humber. Here the land gains upon the sea at Spurn Point, and Sunk Island, which is continually increasing in size. The convergence of the rivers Trent, Ouse, Aire, Dutch River, Don, and Idle, into the great estuary of the Humber, is answerable for an enormous tract of warp and moorland, estimated at 130,000 acres. Extending southwards the same description of land forms the whole of the east coast of Lincolnshire for a breadth of seven miles from the sea to the wolds, until, at Burg, it spreads abruptly westward to Lincoln. A line drawn from Lincoln to Peterborough, then from Peterborough to Huntingdon, and lastly, following the Ouse to the Wash, marks out the main area of the celebrated fen country. South of the Wash, it forms an extensive tract of grazing land known as the "marsh" in Norfolk.

The southern half of the Lincolnshire fen country and its extensions into neighbouring counties form the "Great Level," a tract comprising 310,000 acres. No recent writer understood the fens better than the late John Algernon Clarke of Long Sutton, Lincolnshire, for many years agricultural correspondent to the *Times*, and a practical farmer. The present writer was privileged to know Mr. Clarke intimately, and was convoyed over the district by him. During this tour he derived much information about the fens; and from the summit of Boston church-tower, known as Boston Stump, surveyed the enormous extent of flat land, extending on all sides to the horizon, which included some of the richest agricultural land in England. In driving over this extraordinary district, the main features observable are its unrelieved flatness, the main roads being raised above the dead level and in several cases are laid on, and follow, the line of ramparts constructed in Roman and Mediæval times. It was interesting to note the old churches, and the occasional ruins, upon anciently reclaimed lands, within the Roman sea-wall, and to contrast the features of the older landscape with the more modern appearance of the enclosures effected at later periods.

Outside these more recent developments extended the shallow and gradually silting up waters north of the Wash, and extending into it. It is through this waste of mud and water that the inland drainage has to force its way by scooping out channels, and this is the more remarkable as the coast levels are 12 to 16 feet higher than those on the western limits, from whence the rivers at one time expanded and flooded the entire present fen lands. The usual order is reversed, for the levels are at their lowest on the west and gradually rise towards the sea, rendering artificial assistance absolutely necessary in order to convey the river drainage across the country, and prevent floods. The entire district being below the sea-level, a double defence is needed,—first from the waters representing the drainage of 5000 square miles of inland country in Leicestershire, Bucking-

hamshire, and Suffolk, debouching upon the lowlands; and, secondly, from the encroachments of the tides, which might at any time, if not stayed, devastate the whole vast expanse. This district was the home of the fen men; the dominion of the powerful Abbots of Mendeshampstede (Peterborough) and of Ely, and of the ancient University of Cambridge; the refuge of Hereward, last of the Saxon heroes, and of many bandits and unruly members of society; but the paradise of snipe and water-fowl. A graphic demarcation of the southern portion of the country is recorded in the Anglo-Saxon Chronicle, under the date of A.D. 657, in the reign of Wulfhere son of Penda, King of the Mercians:

"When the monastery [Peterborough] had been hallowed in the name of St. Peter, St. Paul, and St. Andrew, then the king stood up, and said with a clear voice. . . . I Wulfhere do this day give to St. Peter and Abbot Suxwulf, and the monks of the monastery, these lands and these waters, and meres, and fens, and wears, and all the lands which lie hereabouts, which are of my kingdom freely, so that none but the abbot and the monks shall have any claim upon them. This is the grant. From Mendeshampstede [Peterborough] to Northborough, and thence to the place which is called Foleys and thence all the fen straight to Essendic [Essendine], and from Essendic to the place which is called Fethermouth, and thence along the straight way, ten miles to Ugdike, and thence to Ragwell, and from Ragwell, five miles to the straight stream which goeth to Elm and to Wisbeach, and thence about three miles to Trokenholt, and from Trokenholt, straight through all the fen to Derworth which is twenty miles long, and thence to Great Cross and from Great Cross through a clear water called Bradney, and thence six miles to Paxlade, and thence onward through all the meres and fens which lie toward Huntingdon-port, and these meres and lakes Shelfermere and Whittleseymere, and all the others which lie thereabout, with the land and the houses which are on the east half of Shelfermere, and from thence all the fens to Medeshampstede, and from Medeshampstede to Welmsford, and from Welmsford to Clive and thence to Easton, and from Easton to Stamford, and from Stamford even as the water runneth, to the aforesaid Northborough. These are the lands and the fens which the king gave to St. Peter's Monastery."

The vast tract which forms the coast from Filey Bay to the Wash is partly composed of fen and partly of marsh. The former class of land lies on the inland and lower levels, and is black in colour, and of peaty or vegetable origin. The upper soil is more or less mixed with river silt or other débris, beneath which is a stratum of brown spongy moor, containing the leaves and remains of plants. The character of the soil varies according to the locality, sometimes mingled with sand, in others with clay so as to be intermediate between fen and marsh. Between the true fen or black peaty soil and the marsh is found a tract of dark vegetable alluvial loams known as "skirty." This soil has been subjected to paring and burning, which has lowered its level, as after draining it contracted and subsided many feet, until the surface approached the underlying Oxford and Kimmeridge clay. Great improvement was effected by digging up the clay and spreading it from trenches opened 10 yards apart. In some cases the clay could be reached by ploughing, and in both cases the light peaty character of the soil was altered into a vegetable loam of great fertility. By the term "marsh" is understood a laminated marine clay, which is the basis of the fine grazing tract lying east of the Lincolnshire wolds to the sea. In "marsh land" it is chiefly arable, and produces heavy crops of wheat, beans, and potatoes. The

contrast between fen and marsh is emphasised by their different origin. The fens are the result of the natural drainage of rivers which, until the artificial drainage of the district was effected, wandered freely over the low-lying swamps, depositing mud, gravel, and vegetable remains. This was followed, or rather accompanied, by the growth of peat plants, forming "mosses" or peats. The marsh, on the other hand, is the gift of the ocean, and results from tidal action, each tide, or succession of high and low tides, being marked by their laminæ. The estuary of the Humber and its great tributaries is responsible for the growth of marsh land from Filey Bay and Spurn Point, which form the seaboard of Holderness in S.E. Yorkshire, along the whole eastern coast of Lincolnshire to the Wash. The Roman embankment first rescued the Lincolnshire marshes from the sea, and it is on the land-side of it that this particular tract lies. Outside the Roman barrier there have been further reclamations, each successive enclosure being higher than the preceding one, the land rising step by step as the coast is approached. On the Lincolnshire coast, from the mouth of the Welland, along the shore of the Wash, and also up toward Grimsby, although many places have suffered loss by encroachments of the sea, there have probably been a total area of 109 square miles or 69,760 acres, without including any of the Yorkshire (Holderness) enclosures, reclaimed from the waves by embankment within the last two hundred years (Clarke). The Wash itself is slowly silting up, and offers a prize to the engineering skill of the future.

Drainage of the Fens.

It is evident from the preceding remarks that the drainage of the fens, and the reclamation from the sea of marsh lands, are two different objects, in one respect antagonistic. The sea-walls are in themselves a barrier to drainage from the interior, but the Herculean task of draining the fens has been accomplished by deepening existing waterways, and constructing new rivers of such an increasing depth as to secure an outfall over the rising levels which characterise this remarkable area in its seaward direction. The water is allowed to escape through the sea-walls at low tide, by flood-gates and valves, which close against the rising tide.

The drainage of the northern fens of Yorkshire, Lincolnshire, and Nottingham, *i.e.* the districts around Selby, Bawtry, Gainsborough, and Goole, was first undertaken by Sir Cornelius Vermuyden in the reign of Charles I. He and his Dutch engineers widened the river Don and constructed Dutch River, flowing into the Ouse at Goole. The main rivers were embanked, and the river waters, which had deluged the low lands of the Isle of Axholme, were conveyed into the Trent by Snow-Sewer and Althorpe River, emptying through sluices which allowed exit at every ebb tide, and prevented influx at their flow. Vermuyden's work required to be amended, principally because his outfall into the Trent was made too high up the stream, but had it been carried lower down he would have had plenty of fall. As it is impossible to give more than a general idea of the system of drainage adopted, and as the general principle is the same throughout, we turn to the Great Level of South Lincolnshire, which widens out from Burg to Lincoln, and includes Holland fen (22,000 acres) on the west bank of the Witham, drained by 40-feet drains; Witham fen (25,000 acres), running up to Lincoln, and Deeping fen (25,000 acres) north of the river Welland, lying between Spalding and Market Deeping, which was the first extensive tract drained by powerful steam-engines capable of lifting 160 tons of water per minute.

The Bedford Level is south of the Great Level, and is divided into north,

middle, and south. The *north level*, containing 48,000 acres, lies between the Welland and Morton's Leam, which runs from Peterborough toward Wisbeach. The *middle level*, containing 150,000 acres, is the largest of the three divisions, and lies between Morton's Leam and the Hundred Feet or New Bedford River, which conveys the Ouse waters directly across the fens. Here was the well-known Whittlesey Mere, a lake 4 miles wide, but now laid dry. The *south level* (120,000 acres) is drained by over twenty steam-engines, which throw their water into the various main drains and natural rivers intersecting the low lands. Between the rivers, which drain the Bedford Level, are wide spaces of land extending the whole breadth of the fens. Welland Wash contains about 1500 acres; Morton's Leam Wash, between 3000 and 4000 acres; and the Hundred Feet Wash, 21 miles long and from ¼ to 1 mile wide, containing 5000 acres. These "reservoirs" are flooded every winter with from 4 to 7 feet deep of water, but are mown in summer, and yield heavy crops of coarse hay, followed by eddish, stocked with large numbers of young cattle.

The East Anglian fens are not to be compared in extent with the lowlands of Holland, nor is their artificial drainage on such a vast scale as the Netherland Polders, but for a complete system of drainage works they are unequalled for efficiency and completeness. The problem of taking up the water at its lowest level, where it is poured into the vast area from inland rivers, restricting it within bounds, and conveying it across the fens, together with all the surface water, by subsidiary drains, lifted by wind and steam power, and delivering the whole through deeply excavated channels, through sea-walls, into the ocean, is a wonderful achievement.

Agriculture of the Fen Country.

The complete triumph over natural obstacles is shown by the prosperous agriculture extending over what was formerly "mere" and morass. The land is of high average fertility, and is highly cultivated. It grows heavy crops of wheat, beans, oats, seeds, potatoes, kohlrabi, coleseed or rape, and mustard. In many places it can produce flax, hemp, woad, weld, liquorice, and clover seed, while the pasturage of the marshes is of a first-class order. It would carry us beyond our limits to attempt to describe fen farming in detail, especially as there are some other large districts of fen land and marshy ground which ought to be at least noticed in an account of fen lands.

Other Areas of Fen Lands.

A general survey of England reveals the fact that the country as a whole rises westward and northward, from the low-lying lands of East Anglia to the higher midlands, and the still higher lands of Devon, Wales, and the mountainous districts of Cumberland and Scotland. The remaining developments of fens and marsh are naturally found on the east, and extend along the eastern portions of Norfolk, Suffolk, and Kent. In many cases they are alluvial clays, as in the Roothings of Essex, but near the coast, and following the course of the Thames and Medway, they frequently take the form of low marshes. Among these Romney Marsh may be named as a flat tract of grazing land intersected by dykes filled with water and browsed by Romney Marsh sheep. The remaining fens or moors of this particular class occur in various counties, but one of the largest is to be found in Somersetshire, on the borders of the Bristol Channel, or estuary of the Severn, and its many tributaries. The watershed of England divides at the sources of the Severn and the Thames, the one-half flowing westward and the other eastward. Just as the eastern drainage water is the cause

of alluvial soils and flat tracts on the seaboards of the eastern counties, so is the outflow of the Severn accompanied by vast tracts of a similar character. The most remarkable of these is the Bridgewater Level, lying between the Mendip and the Quantock Hills, and forming an irregular parallelogram 16 miles in length from the sea to the south-east, and about 14 miles in breadth between the two ranges of hills. The division which lies between Polden Hill and the Mendips is called "The Marsh," while the other is known as King's Sedgemoor. These marshes include some of the richest grazing lands of the county and of the country. Sir Thomas Dyke Acland informs us in his able essay upon the "Farming of Somerset," that the whole district, which is estimated as composing an area of 200 square miles, was at one time an arm of the sea.

It consists of peats, some of them of immense depth, covered with alluvial deposit, and underlaid by Lias clay, but such is the thickness of the peat deposit, that the clay cannot be brought up to the surface as in the fens of Lincolnshire. There is a great similarity between this vast district and the fens of East Anglia. Both are below the level of the high tides, and in both the level falls from the sea and from the banks of the rivers. Both are protected by sea-walls, and in the Bridgewater Level the drainage has been for centuries in the hands of the Commissioners of Sewers. Courts of Sewers are held at Wington, Axbridge, Wells, Glastonbury, Wincanton, Langport, and Bridgewater, and the first Commission is stated to have been issued in the reign of Edward I. As to the system of drainage, it is in many respects similar to what has already been described, and consists in keeping up the sea-walls, and controlling the rivers by embankments. There is the same system of periodic flooding and drainage, but the objects of thorough drainage are not so scientifically carried out. Sedgemoor comprises much rich grazing land, while other portions are under arable cultivation.

As might be expected, there are no extensive tracts at all comparable with the Great Level of Lincolnshire, or the Bedford and the Bridgewater Levels, in the high districts of the West Midlands; and the next extensive tract of low-lying land of this nature is to be found on the Lancashire coast under the names of Martin Mere, The Fylde, Chat Moss, Trafford Moss, etc. Many thousands of acres of these mosses have been converted into valuable and productive arable land by deepening the rivers and employing steam power to raise the water to the required levels. The fact that the land is often as much as 10 feet below the level of high-water at the spring tides, necessitates sea-walls and flood-gates.

Much might be written upon the drainage works at the mouth of the Ribble, and in connection with the Fylde—a low-lying district of 20,000 acres lying between the Ribble and the Lune—but this article has already exceeded its prescribed length. It may, however, be added that in the course of many rivers, and especially towards their estuaries, similar tracts may be looked for, not only in England, but in Scotland and Wales.

Fences for the Farm.—There is no better sign of general prosperity and good management in any district than efficient and well-kept farm fences. These speak to liberal outlay on the part of the proprietor on the one hand, and to considerable care in upkeep by the tenant on the other; because a good fence means a comparatively large expense to begin with, and constant watchfulness to keep it in order thereafter. On some estates the proprietor takes in hand the maintenance of the more important

among the fences, the roadside ones and the march fences, for instance, charging the tenants a small consideration for this. It is without doubt a good arrangement. It is one, however, that requires a competent estate manager at the head of affairs. If a tight and watchful hand is not forthcoming, there is bound to be more or less slackness in the business. But where it is gone into with promptness and efficiency, an arrangement of this kind gives a stamp, such as referred to above, to any estate in which it is practised. Where there is nothing of this kind, the various farms on an estate—indeed the various fields composing the separate farms—seem all at sixes and sevens. There is no air of tidiness and apparent prosperity, such as characterises the estate the fences pertaining to which are kept in the manner we have been speaking of.

As a farm was bit by bit divided or enclosed internally, the line of each fence followed the line of least resistance, hence the almost universal irregularity of the boundaries of our fields. Wet places and rocky knolls were evaded, the plots of ground capable naturally of responding most profitably to the labour of the cultivator being the first to be enclosed. The poorer places were left out to begin with. By and by the next best plots were enclosed, and so on until the fields came to be very much what they are at present, except that many small ones are now absorbed in those existing. The advent of the art of land drainage no doubt hastened the movement of enlarging fields. But for long after enclosing began in the better favoured or more fertile districts in the bleak parts of the country had the "herd laddie" to take upon himself the office performed by the line of fence. This we see his successors still doing where crofters predominate.

The character of the district ruled the material out of which the fence was constructed. In mossy or peaty soil the turf dyke was erected; sometimes a ditch alone was the boundary. Where stones were abundant on the surface the dry-stone dyke was set up. At some places timber was available, and a barrier was fashioned therewith. It was long before live fences were turned to account. Gradually, however, the hedge appeared in districts where the climate was mild and the soil fertile. In bleak parts it was never thought of. Fence-wire, as we all know, is a thing of recent origin. But so handy is it that it is already in universal use. We have to thank it, however, for being a cause of neglect of the original fences of the country. A little wire comes in remarkably convenient in patching up a defective hedge or wall, which, were the former not available, would in all likelihood receive a more or less radical overhaul. But once begun with, more and more wire is introduced until the fence assumes a nondescript appearance.

The day is surely at hand when fixed fences will be eschewed in our more fertile stretches of land. When shelter is an essential in a farm fence the fixed fence will continue, but wherever this quality can be dispensed with, fences of a more or less portable or movable nature are certain to come into vogue. There is always a margin alongside a fence, no matter of what kind, that cannot be brought under cultivation. Besides the loss of ground in this respect, these untilled parts of our fields are all so many sanctuaries to the endless pests that bring trouble upon our various cropping plants. There they can tide over the lean years to them when the crop they affect does not happen to be alongside any particular line of fence.

The loss of land we refer to is greater than the generality of farmers are aware of. The areas marked on the Ordnance Survey Maps are computed as from the centre lines of the fences, whatever these consist of—whether wall, ditch, hedge, paling, or a combination of two or three of them. Land is now invariably let on the footing of the areas shown on these maps. It

is clear, therefore, that a man who takes a farm on the understanding that when he is to pay so much per acre, according to the figures on these maps, he is to get workable land to that amount, is under a delusion. He is about to pay as much for the ground rendered unworkable by reason of the presence of these fences as for the open parts of the fields themselves. A wire fence (one without stays, that is to say) takes up the very minimum of elbow-room in this connection. Suppose it allows tillage operations to be carried on up to within 18 inches of it on both sides, this means that the fence claims a strip of ground 1 yard in breadth for the whole length it goes. True enough it would at this rate have to stretch out 4840 yards before it occupied an acre of ground. But among small enclosures this would soon be overtaken. Besides, how many farm fences take up so little breadth as one of wire? The rambling hedge—so dear to the artist—sometimes takes up as many yards as the wire fence does feet; more, should a ditch or a bank be an accompaniment thereto.

Were a practicable portable fence available there need be none of this waste of ground, at least very much of it might be avoided. And the places it would be likely to be put to service would just be those where the land was most valuable and where any saving therefrom would be proportionately large. Increased size of enclosure (up to a certain point, of course) means a proportionate saving in the time of tillage work; and without any qualification so does suitability in shape of the enclosed plots which constitute a farm. Gussets, awkward corners, and tortuous fences may be picturesque enough, but they are grievous hindrances to the cultivation of the ground they are part and parcel of. They retard ploughing and harrowing and other tillage work, and are a standing nuisance both at seed-time and harvest, whether the crop be one of grain or roots or tubers. Much of this could be avoided were a fence of the kind we refer to available. That such, of a kind, there is already to be had we shall point out as we proceed.

Besides, a fence of this sort will become a necessity should small holdings ever come to be placed on a workable footing. The ordinary big farm fence is too expensive an affair for small holdings about to be established *de novo.* Finding the buildings will be so severe a strain on the economics involved as to leave little for the provision of fences of any pretended permanence. But had the small holder a suitable portable fence at his disposal, he would each season enclose the parts that were absolutely necessary to be kept to themselves, leaving open the other plots that needed no protection in this way. He would thus be saved the expense of seeking to establish fixed fences even did money happen to be available for the purpose. One comes to understand what an enormous amount of capital has been sunk by landowners in time past, in buildings and fences, when he hears, and begins to consider, sundry proposals for the conversion of large fields into small holdings. The rent of the land would have to be more than doubled in order to pay interest on the capital that would be required to provide suitable buildings and fences—that is to say, buildings and fences in any way comparable with those pertaining to the farms from which it is proposed to take land for small holdings. And then there are roads and drainage more or less to consider.

Straight fences are held to be bad taste by people of artistic temperament, but the rent-paying farmer has usually something else to think about than the æsthetic arrangement of his fields. He may be pardoned seeking to have his more valuable ground—all the arable ground capable of being so dealt with indeed—fenced off in such a manner that he can till it to the best advantage to himself. So may the proprietor who seeks to meet the farmer's

views in this respect. There are usually too many places on a farm where straight fences are, to begin with, impracticable, without any one standing in the way of an improvement of this sort. These afford any proprietor inclined towards artistic effect to follow his bent when so disposed. And seeing it does not matter much what form the permanent pasture fields take, straight fences may at these parts of the farm be altogether avoided.

With the portable fence above referred to at his hand, the farmer would be in a position to shape his fields as seemed best in his own eyes. He could arrange them so as to fall in with his tillage operations as far as practicable. And he would, as we have already implied, save the land that permanent fences occupy; and save his crops from their enemies, which find shelter under wing of these fixed fences. Had there been such available when fences were first instituted, the fixed fence had never on arable ground assumed the important position it now occupies. Those that are still good of their kind have first and last cost too much to justify their being thrown aside; but those on their last legs, if offenders in the manner implied, should, whenever such a step becomes practicable, be ousted in favour of the adaptable one we are advocating.

First among actual fences may safely be placed the white-thorn hedge. He was a far-seeing fellow who, struck with the idea of ranging live plants in a line with a view to their serving as a barrier to animals at pasture, put into practice this method of enclosing land. Until he could fall in with a plant suitable for his purpose, the idea could not bear fruit. A plant capable of withstanding severe pruning and close contact with its fellows in the row, and at same time offer a sturdy resistance against being bent or forced aside by intruders, is clearly the required medium in this respect. And further, a plant not over-particular as regards the nature of the soil, and hardy enough to stand the vicissitudes incidental to a changeable climate, is required for a "live" fence in our country. The white-thorn plant comes up to these requirements in a wonderfully perfect manner. One of our minor trees to begin with, it will stand almost any amount of maiming and contortion of its limbs; and when forced to grow in close line with others, it will mix its branches and leaves with the plants adjoining it in such a way as to leave no distinction between their respective furnishings. Then its tributary branches are not only stiff and tough, but in addition they are armed with thorns that, as many of us know to our cost, can give a good account of themselves. And it is not of such rapid growth as to get unduly out of hand, yet quick enough to make up leeway after a severe trimming or even after a general razing of the plants to within a few inches from the ground. The plant is also adaptive with regard to kind and quality of soil, and can put up with a considerable amount of adverse weather exposure.

We have only one other plant which in any degree approaches to the properties of the white or hawthorn plant as a hedge-former,—the holly. It comes so far short of the latter, however, as to be seldom put to this purpose. The holly stands close contact with its fellows, and bears close pruning; and its branches are not readily thrust aside, even if no respect be paid to the sharp spines on its leaves. Being an evergreen, the holly hedge is a more effective shelter from wind than the thorn hedge. On the other hand, however, the holly is a slow grower, and comes short in hardiness of constitution compared with the hawthorn. It is more expensive too.

Beech and hornbeam are in some districts in vogue as hedge-forming plants, especially where soil and climate are a little unfavourable. These when cramped in the hedge line act as evergreens, and thus afford consider-

able shelter to live stock in the fields. Otherwise they are less effective as barriers than a close row of hawthorn plants.

Hardy and accommodating though the hawthorn be in the matter of submitting to the restraint and trials of the hedgerow, one can easily see that it is deserving of some little attention, if full benefit is to be derived from its position in this respect. It is long-suffering, but even the most patient being has a limit beyond which it cannot be further pressed. In too many cases nowadays is it evident that this limit where the thorn hedge is concerned has been reached. Here and there we see the plants have been allowed to attain to the status of trees. At other places half of them have died out, and the row is full of gaps. Rare, indeed, is it to see an unpatched hedgerow. The hedge is, in fact, already a sadly neglected form of fence. Only in the districts where the land is fertile, and farming is carried on in an intense manner, is the hedge maintained with any degree of decency. Elsewhere it is, speaking generally, rapidly becoming a mere patchwork of wire, rails, and posts, on an irregular groundwork or background of ragged thorns. Nowhere hardly in these parts does one see a hedge being renovated in a radical manner. A hedge is a most expensive fence to begin with, and one that is not often faced now, therefore it is a pity to see so many of them we have falling into dilapidation. Once in that

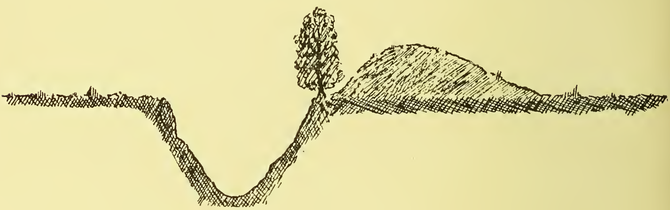


Fig. 1.

condition they are not easily restored to a thorough state of repair. In fact, on high-lying land of a poorish nature, this can hardly be done at all. In these situations it is hardly likely that in future hedges will be chosen when new fences are being projected. Labour is now so scarce and so dear that the hedge has but little chance of receiving the attention that is its due if it is to be of some effect as a fence complete in itself.

To show to the best advantage, the hedge plants must, of course, be planted in favourable soil on a site that is not very much exposed to trying winds. But no matter how well placed as regards other circumstances, if the soil or subsoil in which the hedge stands be wet, it cannot thrive. In forming a new hedge, therefore, steps have to be taken to ensure a dry bed for the plants, should that condition not already exist. On good arable land, dry enough for cropping in the usual way, the young plants may be set without more ado than digging and weeding what is to be the bed of the hedgerow. The plants are ranged 8 or 9 inches apart in the row, three-year-old plants, "twice transplanted," being used for the purpose. Putting the plants in zigzag-wise is perhaps a better arrangement than in a straight line. It gives more room to the individual stems. Usually the plants are thereafter cut over with a sharp pocket pruning knife to within 2 inches or so from the ground; sometimes they are not interfered with in this way. Minor details of this sort depend, however, on the ideas that

may happen to be entertained on matters of the kind by the man in charge of the work, or by the promoter of the same, and on the nature of the soil and climate of the district. They are not of very vital importance however.

For six or seven years at least will the young hedge require to be effectually protected from browsing animals. And during that time all encroaching grass and weeds should be well kept down, so that the young and tender branches may suffer no check. Protecting the hedge means the erection of a temporary fence along each side of the line of the hedge, far enough from it to keep horses and cattle from reaching to the twigs; and keeping the weeds in subjection means a vigorous application of hoe and hook all along the fence twice a year at any rate. Under conditions of this sort, it is not very likely, as we have hinted, that the hedge can be much in vogue when new fences are being formed. It requires times of prosperity in agricultural affairs to justify seemingly unnecessary outlay of this sort. Smaller profits and higher wages than of old are keeping us behind those of a generation or two past in respect of their more thorough work in matters of this kind. For one hedge we plant they must have planted three or four. What is less creditable, we have allowed much of that good work to fall into a disgraceful condition.

On poorer sites it is not often practicable to begin planting without

Fig. 2.

making some special provision for a dry bed for the plants. Generally this is accomplished by forming a ditch, and setting the young plants in the cast-out stuff, as in Fig. 1. This entails extra expense beyond planting on the flat as above described. The hedge has to be protected on both sides as before, with the ditch as an additional item. A fence consisting of two ditches, with a hedge between set in the best of the excavated earth, as in Fig. 2, was by no means an uncommon construction in days gone by, as their remains still testify in some parts of the country. When a ditch or ditches accompany the hedge, there comes to be a good deal of ground abstracted from the ploughable area of the farm. The hedge itself is a considerable sinner in this respect, even when it is kept within reasonable bounds. When neglected, however, it thickens its line accordingly.

At some places a low wall is erected alongside the hedge, as in Fig. 3, only, of course, where stones are to be had without much trouble. This makes a good combination. The weak part of a hedge is close to the ground. There, unless the hedge is in good soil, the stems of the plants are apt to become comparatively bare. It is, however, often where this happens that stones are easily available. A wall two feet or two feet and a half in height, alongside a hedge inclined to become thin near to the ground, rectifies matters in this respect. And while it adds to the efficiency of the hedge, the latter in turn tends to strengthen the wall in its weak part.

The vulnerable part of the hedge being where we describe, the low wall makes good this deficiency. That of the wall such as we refer to being the cope thereof, the hedge as it grows close thereto and overhangs the same, protects it thoroughly from disturbance of either horse, bullock, or sheep. It is evident, however, that unless the hedge be kept in subjection, it will come ere long to wreck the wall as it sways under the influence of the wind. Should there be a slack overseer and a careless tenant connected with a place where fences of this kind exist, a very few years of neglect of these will lead to the ruin of the wall. We have in our mind's eye a district with long stretches of them, in which the hedge plants have been allowed to draw up in tree form and overthrow the wall which was built alongside. The bulk of the stones have disappeared—the best having been taken for repairs of the homesteads and for road metal, the rubbish alone indicating the site of what was once a tidy and efficient job.

More or less fancy combinations of hedges are to be seen in the policy grounds of country mansions. There we may come across a double hedge, if one with the plants arranged as in Fig. 4 may be called such, the two rows being spaced in accordance with taste. Or there may be two separate lines of hedge with a yard or two of ground between. Out in the open,

Fig. 3.

more especially on the home farm, the space between the two is often widened out sufficiently to admit of trees being planted therein. Seldom nowadays, however, does one see the initial work of the construction of fences of this description being set about. It is seldom indeed that we see them kept in the order that a capable manager likes to have them in. Let us hope that when better times dawn upon rural interests, we shall see the hedgerow in its different forms restored to the favour and to the careful treatment it received at the hands of our predecessors in country affairs.

It is not easy to tell how long a thorn hedge should last. One is apt to look upon a fence of the kind as without beginning or end. It can hardly be expected to go on forever all the same. Still, many of the hedges one sees must have been in existence since the ground they are connected with came to be enclosed at first. Indeed, it is truly wonderful how long a fence of the kind will flourish so long as it is well treated. By judicious lessening of bulk now and again, and periodical cutting over and laying of fresh stems, it is practicable to keep renewing the part of the fence above ground. But the underground part, too, should not be grudged some little attention to help it to maintain its vigour. A dressing of good compost of road scrapings and lime or suchlike, applied to the roots on each side of the line, is not lost work where an old hedge is concerned.

Next in importance to the hedge as a farm fence comes the wall or dry-stone dyke. The wall of stone and lime mortar is too expensive an affair to be devoted to this end. Where, however, stone is both plentiful and suitable for the purpose, a very efficient as well as comparatively inexpensive fence can be constructed of these without the use of mortar. The term "dyke," from the Anglo-Saxon word "dic," meaning either a ditch or a bank—the part dug out and the heaped-up diggings as well—is indiscriminately used for all manner of British fences. In one district a dyke implies a ditch or goat; in another, the kind of wall we are discussing; while in one not far removed from either, dyke stands for hedge, wall, or ditch. The dyke we are here concerned with is an erection of stones carefully laid one upon another without the intervention of mortar. It is only in stony districts, of course, that a fence of this description is practicable. Unless in a district where stones are more or less strewn over the surface of the ground, or where suitable rock crops out every here and there, the dry-stone dyke is not had recourse to. Where stone has to be carted any distance to a line of fence, the expense thereof forbids the erection of a dyke. Thus it comes that the dyke is seldom met with in the fertile tracts

FIG. 4.

of Great Britain, unless where they skirt the seashore. Throughout these, as a rule, both soil and subsoil lie deep over the underlying rock, and few boulders are interspersed throughout the soil. This, we need hardly say, is where the hedge thrives best. In the zones between them and the line above which the plough is not in use is the sphere of the dry-stone dyke, as a farm enclosure fence. And beyond this line, on moor and on hill, wherever the ground is firm enough to afford it a footing, is the dyke in question a favourite fence.

When the available stone is in the form of manageable boulders, these are made use of without further ado. The largest of them are rolled into place as the bottom stones of the fence, it rarely being necessary to remove the sward from the line of the dyke previously. This requires to be done in soft places and where there happens to be some depth of soil. We are speaking of moor and hillside, however, because there the projected line of a fence of this kind would be taken along the driest and firmest ground that could be chosen. On arable ground, more or less of a foundation would have to be made; at most, however, but a shallow trench that would grip the first course of stones. With those in place along a convenient length of the dyke, the dykers (in couples), one at each side of the line, raise another

series of boulders on to the top of the first set, and so on until the desired height is attained. The stability of an erection of this sort is due to the unerring knack, which comes to the practised hand, of placing the stones one upon another in the position they have the least tendency to shift therefrom. When this is done, he wedges or keys them all up with angular fragments of stone, thereby locking the whole into one, as it were. This latter operation is also one that comes only from close experience. On it almost depends the permanence of the dyke.

This type of dry-stone dyke is termed the single dyke, on account no doubt of the one-row nature of its construction. Sometimes it is spoken of as the "Galloway" dyke. It is limited to no district however. Wherever boulders of a suitable size are about, there is it to be seen. Its appearance, unfortunately, too often betokens a barren countryside. The other kind of dry-stone wall—the one constructed of quarried stone—is not so suggestive of poverty of soil such as usually follows on a boulder-strewn district. In this case, the stone is not exactly to be had for the lifting, but the parent rock has to be readily available—either bare at parts, or very near to the surface—else the dyke will not be forthcoming. If much excavation in addition to quarrying comes to be involved, dyking of this kind is gone into but sparingly. In fact, when dykes of this sort prevail, it is a clear sign that rock outcrops at many points, and is easily broken up as well.

The dyke of quarried stone is spoken of as the double dyke. The dykers work in pairs in the erection of this kind of dyke too. A special foundation is requisite in its construction. It is not usual, however, to cut much of a trench in this connection. Unless when the ground is soft, little more than the turf is removed. The largest stones are used for the foundation, which is made to project from 4 to 6 inches on either side of the commencement of the dyke proper. This projection is termed the scarcement of the dyke. The building of the fence thereafter proceeds in accordance with a specified gauge. Say that the dyke is to be finished to a uniform height of 5 feet, the gauge or frame would in all probability be one of 4 feet in height, 30 inches at base, tapering at both sides to 16 inches at top. Two frames are set up on the row of foundation stones at a suitable distance apart, and strings stretched from one to the other guide the men in the raising of the wall. When this part has been completed, a row of the flattest stones—the covers or bands as these are termed—are laid in place. These are made to project over each face of the dyke 2 inches or so. This row of stones is for the reception of the copestones of the dyke. These are placed on edge at right angles to the run of the wall.

One hardly needs to be told that the flatter the stones available, the more stable is the dyke likely to be. It is seldom, however, that very flat stones, capable of resisting weather, crop out at the surface. In some flag-producing districts, and where limestone prevails, ideal stone of the kind offers itself for this kind of fence. He is a poor dyke-builder who cannot turn out a first-class job with stone of this sort. Every stone almost has a maximum degree of bedding property, and can hardly be laid so that it or the stones that come above it will not slip out of place. Very different is it, however, where stones so angular that no two faces with the slightest approach to being parallel can be counted on, are the material out of which the dyke has to be built. It requires great art to form stones of this shape into the compact whole represented by a wall-built dyke.

It is usual to stipulate that there must be at least two rows of long stones, termed in this case throughbands, built in the wall to increase its stability. These are laid at right angles to the axis or length of the wall—

across it in short—their ends left projecting some inches beyond either face, in order perhaps to mark their whereabouts. These stones are not placed close together, but at intervals of say of 3 feet. One row is 2 feet or so above foundation level; the other, say, 2½ feet. The stones of the uppermost row coincide with the centres of the spaces between those of the lower one. Without these throughbands or headers a double dry-stone dyke could not be held together for long. They take upon themselves the stresses which serve to scatter the smaller pieces with which the dyke is put together. They relieve the pieces which they overlie from the disruptive tendency of the superincumbent weight. They tie them together as it were, at same time giving each a fair share of the burden. They equalise the strains in short, taking what lies above them on their own shoulders, in addition giving a steady bearing to the stones that constitute this load. The more that can be bestowed on the dyke the greater will be its stability. They are rarely plentiful however; unless, of course, in the cases referred to above, where exceptionally good stones for dyke building are available. When the stone is of the poorest class in this connection, then unfortunately is stuff suitable for throughbands the most difficult to get.

When the copestones are in place, these have afterwards to be carefully pinned or wedged as we spoke of in connection with the single dyke. More or less pinning is needed elsewhere on the two faces of the dyke. But the cope is the most critical part of the double dyke. Any one climbing carelessly over a dyke of this sort is very apt to misplace a stone or two of the cope; and cattle and horses seeking to reach over a dyke to others in the adjoining field are very liable to do the same. Not if the fence is high of course, but it is a fairly high dyke that will prevent two Clydesdales nipping at each other over the top of it. And where sheep are in the habit of scaling walls, copestones are apt to be loosened by them as they scurry over. There are many ways indeed leading to the shifting of these stones. In nearly every case it is well-spent money to secure them with lime mortar.

But here is a short specification for a 5-foot dyke of the kind:—Large flat stones to be used to form the foundation, and these to be wide enough to allow a scarcement of 3 or 4 inches on each side. If the sward is firm and tough they may be laid on this, after what slight levelling of the site which is required has been effected. But if the surface be soft, so much of it must be removed as will admit of the stones having a solid bed on the subsoil. The dyke, when finished, to be 5 feet in height from the surface of the ground to a line running along the top of the copestones; and its thickness to be in accordance with a 4-foot frame 30 inches at bottom—that is to say, on the scarcement—and 16 inches at top. One course of throughbands—seven of them to every 20 feet of building—to be built in 28 inches above ground, the ends of these stones to be left projecting from the face of the wall, and a similar course to be built in at 40 inches above the surface of the ground. The stones of the upper course to be laid above the centre of the spaces between the lower course. The "bands" or "covers" (the flat stones intended to carry the coping) to be laid on the doubling at the height of 4 feet from the surface of the ground, and these must project beyond each face of the wall no less than one inch and a half. The copestones to be securely and firmly fixed on the covers, taking care that none of them is of less depth than 9 inches. The whole of the dyke to be afterwards securely pinned. While in no part is the dyke to be lower than 5 feet above the surface of the ground, at the same time the top must

not rise and fall too abruptly, but it is to be extended in a regularly flowing line by a little extra building where required.

When stone happens to be scarce at the same time that a wall is desirable, a compromise is sometimes arrived at of building one of reduced size and erecting thereon two or three strands of fencing wire. Extra sized stones are built into the copes at regular intervals. To these are fixed wire standards through which the wire is threaded; and with straining posts here and there the wire can be tightened up as desired. This forms an efficient fence. If one of the strands of wire is barbed there is no fear of either horse or cow doing much damage to the cope. Barbed wire is not suitable, however, where sheep are concerned. Besides, sheep will not seek to surmount an obstacle of this sort. A very high wall may not deter a hungry ewe, but she cannot negotiate a wall put together as half-dyke-and-half-wire fence.

There are, of course, other modifications of the dry-stone dyke. Fig. 5 shows one when it is put to service as a sort of retaining wall. This becomes practicable in some situations along the face of sloping ground. The dotted line on the Fig., supposed to represent the surface of the ground before it was interfered with, gives one an idea how much excavation is required in

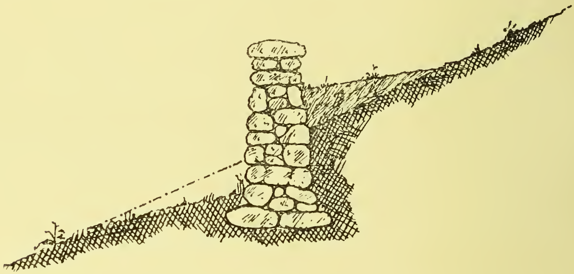


Fig. 5.

a case of this kind. Where, as in this instance, the excavated stuff can be disposed of to advantage on the upper slope, all carting thereof is avoided. Generally, however, there is so much irregularity of surface that the bulk of the excavated earth can be turned to account in hollows not far removed from its old position. On sites not too much exposed for the thorn plant to thrive, a row of thorns planted where shown on Fig. 6 makes a good combination. Indeed, without this qualification a fence of this description is apt to be a bit dangerous. Horses or cattle in the upper division might easily overreach themselves where only a foot or two of wall is between them and the drop into the lower part. It is not very practicable either to raise the clear part of the wall higher than we have indicated. Building it higher would prove too great a strain upon a dyke of the usual dimensions; and to go beyond these is to carry the mortarless wall out of its sphere as a farm fence.

When the circumstances contributing to success are favourable, a hedge thrives well enough in a bed of this sort. As where the hedge is planted alongside the wall, in this case also the hedge conserves the weak part of the wall, serving to protect the copestones from harm by the animals under restriction. But the hedge must be kept in strict bounds else it will soon come

to overthrow the part of the wall that bears on its stems. If kept in good subjection, however, the hedge as it overtops the free part of the wall renders the fence quite an efficient one.

Turning to the less permanent forms of farm fences we find these represented by the different types of timber paling and the various combinations in which wire is used. In England the wooden paling is a more lasting affair than it is in Scotland. In the south, oak or sweet chestnut is mostly in use in this connection, while with us larch and Scots pine are the common woods used. Larch is about as good as the first-mentioned two, besides the practice of creosoting paling timber in Scotland is raising coniferous wood to their level of resistance to decay when put in the trying position incidental to fence timber. All the same the English timber fence is a much heavier and stronger-looking construction than ours. We are content to drive in our paling posts, or stobs, first reducing the end considerably in making it sufficiently sharp to be driven far enough into the ground. In the English fence, on the other hand, holes are excavated for the reception of the post, and the returned earth is well tramped round about

Fig. 6.

these as they are placed in position. We keep ours only 6 feet or so apart; they as much again. But then we use rails 3 or 3½ inches by ⅞ of an inch, nailing them to the faces of the stobs; while they use spars generally ungauged, firmly mortising their ends into the posts, which are much heavier than those we use. But in Scotland the post and rail fence is looked upon as a makeshift at best.

Our lighter material of this kind puts us, however, on a better footing with regard to the erection of the post and wire fence. This class of fence now occupies a very important place in the majority of north country farms. Where hunting prevails it is of course taboo. Elsewhere, however, it has spread to the detriment both of hedge and dyke. The materials being comparatively cheap, handy to erect, and little carting being involved, it often occurs that rather than renew a hedge that has been allowed to become useless as a fence, or restore a dyke that has become ruinous, a wire fence is run up alongside, and the old one thereafter left to its own devices. From a sixpence to a shilling a running yard, all according to situation and other circumstances, suffices to erect an efficient fence of

the kind. Five or six wires are requisite wherever sheep are being restrained; three or four answer the purpose when cattle alone are in the enclosures.

The following gives a specification applicable to an ordinary wood-post and wire fence:—The stobs or posts to be all of larch, 5 feet long, a due proportion of them 5 feet 6 inches for use in hollows. Timber, $5\frac{1}{2}$ inches in diameter, may be split up to form two posts, and pieces 7 inches in diameter may be quartered into four; all of them to be peeled, pointed, and driven in 6 feet apart from centre to centre. Straining posts to be fixed up at every hundred yards, these to be of iron $1\frac{3}{8}$ inch square. The straining posts at the extremities of the fence, together with those at angles on the line thereof, to be strengthened with iron stays $1\frac{1}{8}$ inch square. The ends of the straining posts and stays to be sunk 5 inches into large stone blocks of sufficient weight to resist a good strain on the wires, and be batted firmly into the same with lead (good stout pieces of timber may, of course, be substituted for the iron posts and stays). Five wires to be used, all of them well stapled to each post; the two top wires to be No. 4 and the three lower ones No. 6, all of the best bright wire. When completed, the fence to stand from 3 feet to 3 feet 4 inches high on the average; and after the final touch has been given, all the wood, wire, and iron above ground to get a coat of coal tar. Galvanised wire is sometimes used, thus serving the necessity of tarring or varnishing the wire. And strand instead of single wire is sometimes used. Wherever it is practicable the posts should be treated with some preservative against decay (*see* "Creosoting of Timber"). If nothing else, the ground ends might be charred.

Our American cousins, with their genius for adaptiveness, are making use of Portland cement concrete as a substitute for wood and iron in the matter of both fence and gate posts.

A wire fence is never satisfactory as a division between fields in each of which there are cattle or horses devoted to breeding purposes. The separated animals see each other so distinctly, and can touch and smell one another so readily, that there is seldom peace in the neighbourhood of the barrier. On this account both fence and animals come more or less to grief. Many a good horse has been spoiled through becoming entangled in a wire fence. A strand of barbed wire at the top serves as a stand-off to combative or amative animals on either side, so long as these have already made acquaintance with this barbarous preventive. It may at times, however, be forgotten by the knowing ones even. Besides, unsophisticated animals are occasionally being introduced into the fields; and again both knowing and ignorant are liable at times to be pushed against the fence when a disturbance arises.

On the sheep-walk a fence of this description answers well. It can be extended wherever there is depth of earth to give a footing to the posts. It is so light that yielding mossy land can give it a bearing. Thus it can be erected where the dyke could not stand. Whenever, indeed, the latter is impracticable, the post-and-wire fence can be adopted. In the proper sphere of the dyke, there, too, so long as there is enough earth overlying the rock, is it quite practicable, often indeed, on account of its lesser cost, preferable. The weak point of this fence is that it affords no shelter—a matter of considerable importance on moor and hillside. Everywhere about the farm, this is an important point, but the first essential of a fence being to turn grazing stock, it seems bad policy to seek to graft upon it the onus of having to protect them to some extent from wind as well.

Shelter is often very welcome, however, especially where the farm has not a very favourable exposure. It may not be much missed where the land is fertile and the local climate good. Here it may be that shade is more acceptable than shelter. Both the dyke and the hedge, in correspondence with their height, afford effective shelter from the wind as it blows against either side. Neither is capable, however, of affording shade; at any rate where the hedge has attained a condition which enables animals to benefit from its shadows, it has outgrown its real function as a fence. Both shelter and shade, therefore, had better be provided for in a special manner, rather than that we should seek to throw this extra office upon the fence proper.

Fences all of wire are now available for the farm; fences we mean in which the standards and stays which support the wire are of iron instead of wood, as referred to above. When wood is scarce, and a wire fence has

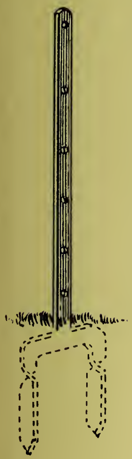


Fig. 7.

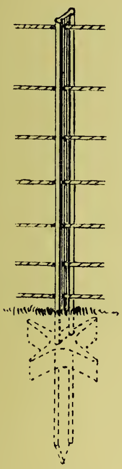


Fig. 8.

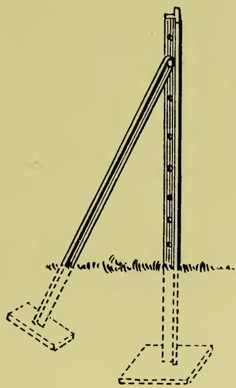


Fig. 9.

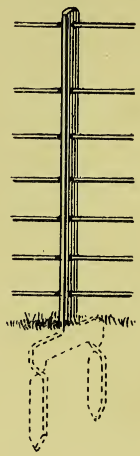


Fig. 10.

been settled upon, a fence of this description comes in appropriate. A flat iron standard with feet or prongs, as on Fig. 7, was until lately the accepted substitute for the wood post. Now, however, standards of T, Y, bulb, and H iron, variously modified with movable plates or shoes, as represented on Fig. 8, are largely used for giving stability to the standards. Side stays are, of course, required whenever the line of fence follows a curve, and it points where it strikes off at an angle. When stones are not available, plates, such as Fig. 9 shows attached to the end of the stay and standard, give these the necessary resisting power against either wrench or thrust.

Fig. 10 represents a fence, with the kind of standard shown in Fig. 7 in position. The specification runs thus: This fence stands 4 feet high from ground, has seven lines of best drawn annealed black wire; the top one No. 4 gauge, and six lower No. 6 gauge. The standards are of $1\frac{3}{8}$ inch $\times$ $\frac{3}{8}$ inch flat iron; they are spaced 9 feet apart, and have double-pronged feet, which go 14 inches into the ground. The whole of the material

(excepting the wire) is covered with one coat of best jet varnish. This is quite a suitable fence for moorland, which carries sheep principally. On Fig. 11 is given a fence, erected with one of the other kind of standards given above, but with a so-called dropper between each pair. The specification for it is: The fence stands 4 feet high from ground, with six lines of wire, top one galvanised ordinary four-points steel barb, and five lower wires, No. 5 gauge, best galvanised seven-ply strand. The standards are of patent Y iron, spaced 10 feet apart, and go 21 inches into ground, with cast-iron wing earth plates, and one steel dropper between each. The whole of the material (excepting the wire) is covered with one coat of best jet varnish. This is a stronger fence than the other, fit to do service where cattle as well as sheep are being grazed.

The droppers referred to do not, it may be seen, touch the ground at all. Their purpose is to keep the wires at their due distance apart from one another. Their use serves to keep the standards further apart, and thereby

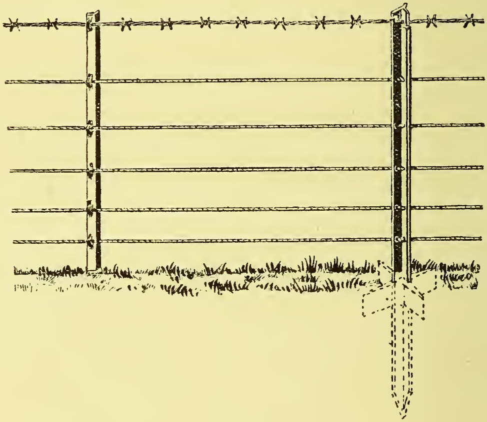


Fig. 11.

lead to economy without much loss of strength. In some specially contrived light fences for sheep-runs the standards are as far as 48 feet from each other, with half a dozen droppers between. The straining parts are numerous, however, and the wire of a special quality.

There are many other fences similar in type to these, which to describe and depict would be simply to borrow further from the exhaustive catalogues of the leading manufacturers of commodities of this kind. Among them are, of course, the many patterns of iron fences, with rails or rods instead of wire. But there are more permanent fences and costlier than one feels justified in recommending for the farm. Their place is in connection with the pleasure grounds or policies round the mansion-house on the estate. All the same it seems to us that iron is hardly the material to put to use to any great extent amid the rural surroundings of the country residence. There are other materials better suited to the purposes of fence erecting in these situations than utilitarian iron.

With regard to the movable fences hinted at above, something on the

lines of those depicted by Figs. 12 and 13 would answer the purpose of a temporary barrier. These will stand being taken down and re-erected on a fresh site several times in a nineteen-year lease. A fence of this sort is

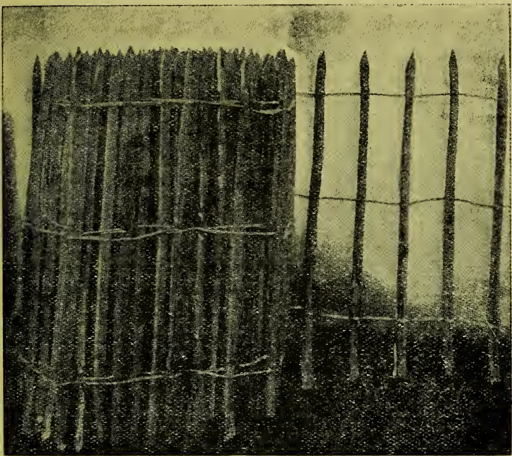


FIG. 12.

FIG. 13.

simple in construction, while the materials used are both comparatively cheap and lasting, seeing they are but cleft or split chestnut poles and good tough wire. Fig. 14 represents a machine (protected by patent by a firm of land agents in the south of England) for the construction of such a fence.

The whole thing is so plainly revealed by the diagram, that we need spend no time in explanation of its way of working.

This sort of fence is now in the market in many forms—some suitable to turn sheep, others quite formidable enough to keep cattle and horses within bounds as well.

The fence represented in Figs. 15 and 16, Tozer & Son's "lock-woven steel wire fencing," shows another style of barrier of the kind we are referring to.

It is seemingly, however, better adapted for permanent than for casual use. "Woven 50 inches wide to make 4 feet 6 inches fence, when erected," the makers say, "spacing and gauge of wires as indicated; upright wires 13 to 13½ inches apart. In rolls of 150, 100, and 50 yards. Perfectly proof against the heaviest stock, an ideal fence for all purposes." There are, of course, modifications thereof. They say further, that "owing to the wide spacing apart (18 to 50 feet) of [wood] posts or [iron] standards, and to the fact that straining posts are only required at end or angles, there is a

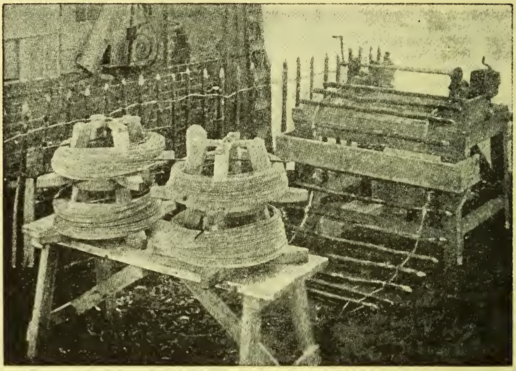


FIG. 14.

great saving in cost of material and time in fixing, making it cheaper than any ordinary wire fence when erected. We are prepared to erect, at lowest possible cost, all fencing supplied by us, and for 'fixed' contracts, our prices, including wrought-iron straining pillars, standards, and fencing, and all labour, run from 11½d. per yard, according to type of fence, quantities, number of straining pillars, nature of ground," etc. A fence of this kind seems to be on the lines we suggested with regard to the adoption where intense farming is practised, of less archaic forms of fences than the ordinary sorts in use.

We need hardly urge further on our readers the benefit that would result from the use of fences of this description in connection with fertile and well-protected ground. Their use would obviate the direct loss of ground and other drawbacks which follow in the wake of the fixed fences we are still content to put up with in these positions. What is in good enough place, where land is cheaper and labour has not to be so strictly economised, is not very excusable where strictly scientific methods are supposed to rule. Besides, as we have said, something of the kind will be essential

should small holdings ever spread to the extent that their well-wishers would have them attain.

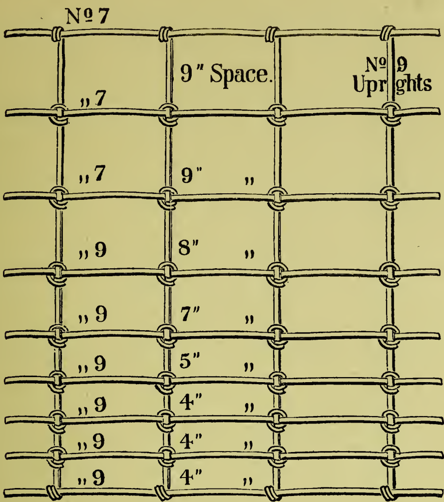


Fig. 15.

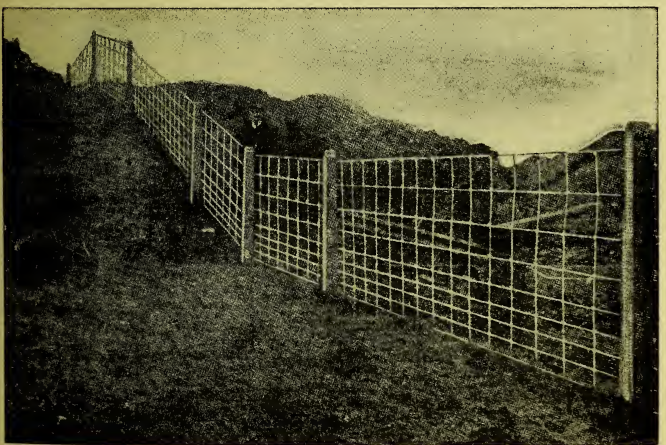


Fig. 16.

Gates may be of many kinds, but the well-hung swing gate is generally to be preferred.

Fermentation was until comparatively recently thought to be a purely chemical process, but we owe to Pasteur the discovery that it is due to the work of micro-organisms; although their decomposing action is accompanied by chemical action, under which new but distinctly fermentated products are produced. The most familiar example is that of the conversion of sugar into alcohol, but, besides alcoholic fermentation, there is acetic fermentation or the formation of vinegar from alcohol; lactic fermentation, resulting in the souring of milk; butyric fermentation, which produces butyric acid in butter, and many others. Fermentation has therefore become the joint study of bacteriologists, physiologists, and chemists. It is closely associated with putrefaction, but, popularly understood, is not offensive, and usually operates upon carbohydrates such as sugar, starch, milk-sugar; or upon hydrocarbons, such as fats and alcohols. It requires the presence of a "ferment" of nitrogenous character, but the action is not set up without the presence of micro-organisms.

If these are excluded by sterilisation, fermentation is impossible, as is exemplified in the preservation of many vegetable and animal products. Pure forms of carbohydrates, such as sugar, starch, or of the fats and oils, are only subject to fermentation when associated with nitrogenous matter, such as the albuminoids, and these only after the invasion of germs. Yeast and the vinegar plant are familiar examples of ferments, as is also the "kindling" sometimes added to cream in order to promote ripening before churning. Fermentation is always accompanied by the evolution of carbonic acid gas in large quantities, which imparts a sparkling character to wines and beers. It is closely allied to decomposition or putrefaction, and, according to the older chemists, to slow combustion, or eremacausis. Combustion, whether fast or slow, is not, however, fermentation, as micro-organisms are not necessary to produce it; whereas true fermentation is always associated with the presence of germs.

Putrefaction is so similar to fermentation that the two processes have been regarded as impossible to separate, and in fact to be identical. Putrefaction occurs in more complex material, such as in nitrogenous vegetable and animal refuse, and is characterised by the evolution of ammonia, sulphuretted hydrogen, and offensive odours of uncertain composition. It, like the more beneficent and definite forms of fermentation, requires the presence of micro-organisms (*see* Denitrification), but is much more complicated and undesirable, unless rendered necessary in the fermentation or rotting of manure (*see also* Bacteriology) or other processes of degradation for special purposes.

Fertility in Soils.—*See* Soils.

Fertilisers and Feeding Stuffs Act, 1906.—This Act and the Orders made under it by the Board of Agriculture and Fisheries (called in this article the Board) contain the statutory safeguards afforded to purchasers of fertilisers and feeding stuffs.

Fertilisers.—Every person who sells for use as a fertiliser of the soil any article which has been subjected to any artificial process in the United Kingdom, or which has been imported from abroad, must give to the purchaser an invoice stating the name of the article and the percentages (if any) of nitrogen, soluble phosphates, insoluble phosphates, and potash contained in the article; and the invoice shall have effect as a warranty by

the seller that the actual percentages do not differ from those stated in the invoice beyond the prescribed limits of error. Any statement of the chemical or other ingredients contained in a fertiliser made in an invoice or in any circular or advertisement has the effect of a warranty (S. 1).

As to fertilisers mixed at the request of the purchaser, see *infra* (*Feeding Stuffs*).

Limits of error.—These have been fixed by Order No. 946 of 1906, the First Schedule to which is as follows:—

First Schedule.

FERTILISERS.

Note.—In this Schedule the figures relating to limits of error represent percentages of the whole bulk.

Example of application of Schedule.—*e.g.*, In the case of a bone compound, if the percentages stated in the invoice are, soluble phosphates, 20; insoluble phosphates, 8; nitrogen, 1; then the warranty implied under s. 1 (1) of the Act will be that the fertiliser contains, soluble phosphates, 19 to 21 per cent.; insoluble phosphates, 7 to 9 per cent.; nitrogen, ·7 to 1·3 per cent.

Description of Fertiliser.	Limits of Error.			
	Soluble Phosphates.	Insoluble Phosphates.	Nitrogen.	Potash.
1. Superphosphate	1	...	...	...
2. Dissolved Bones (Vitriolised or Vitriolated) made from Raw Bones and Acid only:—				
(I.) When the total of the percentages of Phosphates (soluble and insoluble) stated in the invoice amounts to 32 or more, then—				
(*a*) If the excess of the actual percentage of insoluble Phosphates over that stated in the invoice is 3 or more . . .	4	...	·3	...
(*b*) If such excess is not less than 2, but is less than 3.	3	...	·3	...
(*c*) If such excess is not less than 1, but is less than 2.	2	...	·3	...
(II.) In all other cases	1	1	·3	...
3. Bone Compounds	1	1	·3	...
4. Compound Manures (other than Bone Compounds, but including Dissolved or Equalised Guano):—				
(*a*) If the respective percentages of Nitrogen and Potash stated in the invoice do not exceed 4	1	1	·3	·3
(*b*) If such respective percentages exceed 4 .	1	1	·5	·5
5. Sulphate of Ammonia	...	...	·5	...
6. Nitrate of Soda	...	...	·5	...
7. Ground Hoofs and Horns	...	...	·5	...
8. Dried Blood	...	...	·5	...
9. Fish Guano and Meat Meal	...	2	·5	...
10. All Cakes and Meals (other than Bone or Meat Meal)	...	...	·5	...
11. Ground Bones and Bone Meal	...	2	·5	...

First Schedule.—FERTILISERS—(*continued*).

Description of Fertiliser.	Limits of Error.			
	Soluble Phosphates.	Insoluble Phosphates.	Nitrogen.	Potash.
12. Basic Slag and Basic Superphosphate	2[1]	2	...	...
13. Shoddy, Wool, and Hair Waste	...	...	1	...
14. Kainit and other Potash Salts:—				
(*a*) Where the percentage of Potash stated in the invoice does not exceed 15	...	...	...	1
(*b*) Where such percentage exceeds 15	...	...	...	2
15. Nitrate of Potash	...	...	·5	2
16. Peruvian and other natural Imported Guanos:—				
(*a*) Where the percentage of insoluble Phosphate stated in the invoice does not exceed 30	...	3	...	·5
(*b*) Where such percentage of insoluble Phosphate exceeds 30	...	5	...	·5
(*c*) Where the percentage of Nitrogen stated in the invoice does not exceed 3	...	...	·5	·5
(*d*) Where such percentage of Nitrogen exceeds 3 and does not exceed 5	...	...	·75	·5
(*e*) Where such percentage of Nitrogen exceeds 5	...	...	1	·5

[1] That is, soluble in a solution of citric acid of the prescribed strength.

"Soluble" and "insoluble" mean, soluble and insoluble in water, or, if so specified in the invoice, in a solution of citric acid or other solvent of the prescribed strength, and the percentage of soluble phosphates and of insoluble phosphates mean the percentage of tribasic phosphate of lime which has been, and that which has not been, rendered soluble. When in an invoice relating to basic slag or basic superphosphate it is specified that a certain percentage of the phosphate contained in the basic slag or basic superphosphate is soluble in citric acid, this shall be taken to mean that it is capable of being dissolved to the extent of such percentage when 5 grams of the fertiliser and 500 cubic centimetres of water, containing 10 grams of citric acid, are continuously agitated in a flask or bottle of about 1 litre capacity for the period of half an hour at the ordinary temperature (Order 944 of 1906).

Analysis.—The Board appoints a chief analyst, who must not engage in private practice. Every County Council must, and the Council of any County Borough may, appoint an agricultural analyst and one or more official samplers, and also, if they think fit, a deputy agricultural analyst. These appointments are subject to the approval of the Board. An agricultural analyst must not engage or be interested in any trade, manufacture, or business connected with the sale or importation of fertilisers or feeding stuffs (S. 2).

Every purchaser of a fertiliser or feeding stuff who has taken a sample thereof within ten days after delivery or the receipt of the invoice, whichever is the later, may have the sample analysed by the agricultural analyst on payment of his fee (S. 3 (1)). An official sampler shall at the request of a purchaser who has paid the required fee, and may without such request, take a sample of any fertiliser or feeding stuff which has been sold or is

exposed or kept for sale; if the article has been sold, the sample must be taken within ten days of the delivery or the receipt of the invoice (S. 3 (2)). If the sample has been taken with a view to civil or criminal proceedings, the person taking it must divide the sample into three parts, which must be marked, sealed, and fastened up. Two of these parts must be sent to the agricultural analyst and one to the seller (S. 3 (3)).

If the sample has not been so divided, etc., as set out above, the agricultural analyst sends a certificate of his analysis to the person who submitted the sample. If it has been so divided, he analyses one of the parts and retains the other, and sends certificates of his analysis to the person who submitted the sample, the purchaser, the seller, and any other person who may be prescribed, and reports the result of his analysis to the Board (S. 3 (4)).

At the hearing of any civil or criminal proceedings the production of a certificate of analysis of the agricultural analyst or the chief analyst is sufficient evidence of the facts therein stated, unless the defendant or person charged require that the person who made the analysis be called as a witness. This subsection does not apply where the sample has been taken otherwise than in the prescribed manner, nor where it has not been divided up, etc., as stated above (S. 3 (5)). If either party objects to the certificate of the agricultural analyst, he is entitled, on payment of the required fee, to have the part retained by the agricultural analyst analysed by the chief analyst (S. 3 (6)). When a sample is sent for analysis under this section, the invoice or a copy of it must be sent with the sample (S. 3 (7)).

The Board have made very elaborate regulations as to the manner in which samples shall be taken and also as to the form, etc., of the analysts' certificates. These regulations are too lengthy to be set out here, but will be found in Orders 944 and 945 of 1906 issued by the Board. The regulations do not prevent a purchaser from having an analysis made otherwise than in accordance with the regulations (S. 4).

A purchaser may appoint an agent for the purposes of the Act in the form given below, which is taken from Order 945 of 1906, or in any form to the like effect.

I, A. B. of   , hereby appoint C. D. of   , *or* the Secretary for the time being of the   Association [*or as the case may be*], to do on my behalf all things necessary for the purpose of obtaining an analysis under the Fertilisers and Feeding Stuffs Act, 1906, of the fertiliser *or* feeding stuff bought by me under an invoice, a copy of which is annexed.

Feeding stuffs.—Every person who sells for use as food for cattle (*i.e.* bulls, cows, oxen, heifers, calves, sheep, goats, swine, and horses (S. 10)) or poultry, any article which has been artificially prepared, shall give to the purchaser an invoice stating the name of the article, and whether it has been prepared from one or more than one substance or seed, and in the case of any article artificially prepared otherwise than by being mixed, broken, ground, or chopped, what are the respective percentages (if any) of oil and albuminoids contained in the article, and the invoice shall have effect as a warranty by the seller as to the facts so stated, except that as regards percentages the invoice shall have effect as a warranty only that the actual percentages do not differ from those stated in the invoice beyond the prescribed limits of error.

If a feeding stuff is sold under a name or description implying that it is

prepared from any particular substance or substances, or is the product of any particular seed or seeds, and without any indication that it is mixed or compounded with any other substance or seed, there is an implied warranty by the seller that it is pure and is prepared or is the product of those substances or seeds only. There is an implied warranty that all feeding stuffs are suitable to be used as such. Any statement of the nutritive and other ingredients contained in any feeding stuff made in any invoice or in any circular or advertisement has the effect of a warranty by the seller.

Where a fertiliser or feeding stuff consists of two or more ingredients, which have been mixed at the request of the purchaser, the invoice need only contain a statement of the percentages of the several ingredients before mixture, and that they have been mixed at the request of the purchaser (S. 1).

Limits of error.—The limits of error as regards feeding stuffs are contained in the Second Schedule to Order No. 946 of 1906, which is as follows:—

Second Schedule.

FEEDING STUFFS.

Note.—In this Schedule the percentage of albuminoids is to be taken as the percentage of nitrogen multiplied by 6·25.

Example of application of Schedule.—*e.g.*, In the case of a linseed cake, if the percentages stated in the invoice are, oil, 10; albuminoids, 30; then the warranty implied under s. 1 (2) of the Act will be that the linseed cake contains—oil, 8·75 to 11·25 per cent.; albuminoids, 26·25 to 33·75 per cent.

Description of Feeding Stuff.	Limits of Error.
Decorticated Cotton Cake or Meal Undecorticated Cotton Cake or Meal Earth Nut or Ground Nut Cake or Meal Palm Kernel or Palm Nut Cake or Meal Cocoanut Cake or Meal Niger Seed Cake or Meal Sesame Seed Cake or Meal Sunflower Seed Cake or Meal Hemp Seed Cake or Meal Kurdee or Safflower Cake or Meal Compound Cakes and Meals	One-tenth of the percentage of oil and one-tenth of the percentage of albuminoids stated in the invoice.
Linseed Cake or Meal Rape Cake or Meal Maize Products	One-eighth of the percentage of oil and one-eighth of the percentage of albuminoids stated in the invoice.
All other feeding stuffs (as above defined in Regulation 2) not otherwise specified in this Schedule	One-fifth of the percentage of oil and one-fifth of the percentage of albuminoids stated in the invoice.

The provisions as to analysis of feeding stuffs are the same as those with regard to fertilisers (see above).

Offences and penalties.—Any person who—

(*a*) fails without reasonable excuse to give, on or before, or as soon as possible after delivery, the invoice required by the Act; or

(*b*) causes or permits any invoice or description of an article sold by him to be false in any material particular, to the prejudice of the purchaser; or

(*c*) sells any feeding stuff containing any ingredient deleterious to cattle or poultry, or to which has been added any ingredient worthless for feeding purposes which has not been disclosed at the time of sale

is liable, without prejudice to any civil liability, on summary conviction to a fine not exceeding £20 for the first offence and not exceeding £50 for any subsequent offence. No person is liable to be convicted under (*b*) if he proves that he did not know and could not with reasonable care have ascertained that the invoice or description was false; or that he purchased the article with a written warranty or invoice from a person in the United Kingdom, and that that warranty or invoice contained the false statement, and that he had no reason to believe that the statement was false, and that he sold the article in the same state as he purchased it.

It is no defence that the article was purchased solely for the purpose of analysis.

The consent of the Board must be obtained before a prosecution is instituted, and before that consent is given the part of the sample retained by the agricultural analyst must have been analysed by the chief analyst.

The summons must state particulars of the offences alleged and the name of the prosecutor. It must not be returnable less than fourteen days from the date of service, and a copy of any analyst's certificate obtained on behalf of the prosecutor must be served with it (S. 6).

Any person who fraudulently

(*a*) Tampers with any article so as to procure that any sample of it taken under the Act does not correctly represent the article; or

(*b*) Tampers with any sample taken under the Act

is liable to a fine not exceeding £20, or imprisonment up to six months (S. 7).

If the owner or any person intrusted for the time being with the charge or custody of any article sold or intended to be sold for use as a fertiliser or feeding stuff refuses to allow an official sampler to take a sample for the purposes of analysis, or if the purchaser of any such article refuses to give an official sampler the invoice of the article or a copy of it, he is liable to a fine not exceeding £10 (S. 8).

Prosecutions may be instituted, with the consent of the Board (see above), by the person aggrieved, the local authority, or any body or association authorised in that behalf by the Board.

Prosecutions for causing or permitting an invoice or description to be false in any material particular cannot be instituted after the expiration of three months from the receipt of the invoice, and unless a sample has been taken and analysis made by the agricultural analyst and a certificate of analysis given in accordance with the Act.

Proceedings may be taken either in the place where the purchaser resides or carries on business, or in the place where the invoice or description was given.

There is an appeal to Quarter Sessions (S. 9).

The Act applies to both wholesale and retail sales (S. 10 (1)).

The Act applies to England, Scotland, and Ireland.

Scotland.—"Council of a County Borough" means the Town Council of a burgh. The expenses incurred are defrayed out of a rate levied, fixed, and paid in the same way as the local rate under the Diseases of Animals Act, 1894. Penalties may be recovered summarily before the Sheriff as provided by the Summary Jurisdiction Acts, and any person aggrieved may appeal as provided by these Acts (S. 11).

Ireland.—The duties and powers of the Board are vested in the Depart-

ment of Agriculture and Technical Instruction for Ireland; for the purposes of prosecutions the Department may take samples of fertilisers or feeding stuffs which have been sold or are kept or exposed for sale (S. 12).

Fescues.—The fescues are a very extensive group of grasses belonging to the genus *Festuca.* About eighty species are known. They are chiefly found in cold or temperate regions; and some of them are among the most nutritious constituents of pastures and meadows on all classes of soil.

The inflorescences are panicles, some large and open, others small and contracted. The spikelets contain three or more flowers. Empty glumes generally two, unequal and shorter than the rest of the spikelet. The flowering glumes are rounded on the back, usually with a terminal or very slightly dorsal awn of variable length. The ovary is glabrous, and the styles are terminal.

The rachilla is jointed between the flowering glumes, and bears a characteristic flattened apex where the parts of the joint separate from each other.

Two fairly distinct sections may be recognised, one with broad flat leaves, the other with narrow leaves, which in extreme forms are almost cylindrical and bristle-like.

The following are broad-leaved:—

1. Meadow Fescue (*Festuca pratensis*, Huds.).—A tall perennial species, 2 to 3 feet high, met with in all the best pastures on good soils, especially where there is a fair amount of moisture.

It grows in loose tufts, which tend to spread, and sends up flowering stems which end in open panicles of spikelets, which are individually somewhat like those of perennial rye-grass. The flowering glumes are awnless.

Meadow fescue is among the best of all "top grasses." It is early, grows well after cutting or grazing, and is nutritious and freely eaten by all classes of farm animals.

The grass should not be used for short leys, as it is slow in development, but it should form a large portion of all mixtures for laying down land permanently.

The best results are obtained from it on good land. On dry poor soils it does not thrive. Like all the larger grasses, it should be cut for hay before or about the time of flowering. After this time it is apt to become woody and less digestible.

The seeds resemble those of the much cheaper perennial rye-grass, so that care is needed in purchasing commercial samples.

F. loliacea, Curtis, has a simple spiked inflorescence, not branched as in the typical meadow fescue. It is infertile, and supposed to be a hybrid between meadow fescue and perennial rye-grass.

2. Tall Fescue (*F. elatior*, L.).—This is a coarse-growing species, of which meadow fescue is possibly only a smaller form or sub-species. It has a creeping root-stock, with stems 2 to 6 feet high, large flat leaves in tufts, and is chiefly met with on river banks and in wet places.

A rougher form growing near the sea is *F. arundinacea*, Schreb. These are too coarse to be of much agricultural value, except in rich moist situations near streams or the seashore. Stock readily eat all these fescues when not too ripe.

The following narrow-leaved fescues are of agricultural interest:—

1. Sheep's Fescue (*F. ovina*, L.).—A common perennial, found on all

the best sheep pastures, especially on dry uplands. It grows in tufts a few inches high, and has very thin bristle-like leaves. The flowering stems appear in June and bear small purplish panicles, the spikelets of which consist of three to ten flowers. The flowering glumes have short awns or points.

A smaller form, with very thin leaves and almost awnless glumes, is termed fine-leaved sheep's fescue (*F. tenuifolia*, Sibth.).

2. Hard Fescue (*F. duriuscula*, L.) is a less densely tufted species, taller, with flat leaves and downy leaf-sheaths. The spikelets have well-developed awns. It is common in dry and loamy pastures and meadows throughout the country.

3. Red Fescue (*F. rubra*, L.) resembles hard fescue in general appearance, but is somewhat taller, with more marked stoloniferous habit.

Meadow Fescue.

Hard Fescue.

The spikelets are pale red, and the flowering glumes are awned. The typical plant grows in dry sandy places.

These narrow-leaved fescues are exceedingly variable plants, and many forms exist, which in morphological characters are intermediate between those described. They are probably all variable forms of one and the same fundamental species, and commercial samples of seeds are rarely true to type.

The yield of produce from these narrow-leaved fescues is comparatively small; they are nevertheless useful constituents of pastures, since they provide nutritious food for stock on land which is dry and poor. What the leaves lack in bulk they make up in numbers.

They are of no use for short leys, but should be used in all mixtures of seeds for permanent pastures, the smaller type or sheep's fescue being employed where the land is hilly, rocky, and dry, the somewhat broader-leaved taller forms—hard and red fescues—being selected where the land to be laid down is of better quality. True red fescue is perhaps the best of

the forms for formation of a good sole of turf. They are all useful for the formation of lawns, where a compact turf is needed which requires little mowing.

Fiars Prices.—Fiars prices is the term used to indicate standard prices of grain annually fixed by the Sheriff, the objects being to settle the rate at which the stipend of the parochial clergy and any other money payments referable to the current value of agricultural produce are to be converted into money. The term "fiar" has no relation with the same word signifying an owner of heritable property, but is identical with the Middle English *feor*, Old French *feur*, a price, being a derivative from Latin *forum* in the sense of a market, and thence a market price. The word "affeer," to fix a price, also occurs, but is not to be confused with *affeir* or *effeir*, a term still in use in Scots legal phraseology, meaning to pertain. The word "fiars" thus signifies market prices, and is used in that sense in the Act 1584, c. 22 ("appoint certane and indifferent and comoun prices als neir as may be to the feiris of the cuntreis").

One of the earliest objects of fiars was to fix the money conversion of rents payable in grain, where such conversion had not been fixed in perpetuity by the agreement of parties; and as the Sheriff was then a fiscal officer of the Crown, it was his duty to fix the prices at which such Crown rents were to be converted; hence, no doubt, the origin of the expression *Sheriff-fiars.* Owing to complaints of irregularities in the method of striking the fiars, an Act of Sederunt was passed in 1723 which provided that the Sheriff should strike the fiars before March 1st in each year. The procedure was to summon a jury of fifteen (of whom eight should be heritors), and also witnesses who had been engaged in sales of grain; but the jury could also act on their own knowledge. There is considerable doubt whether the Court of Session had any jurisdiction to pass this Act, as the authority of the Sheriff to strike the fiars must have emanated from the Exchequer. In the case of *Howden* v. *E. of Haddington* (1851, 13 D. 522), the Court of Session refused to interfere where the fiars had been struck for a long period in a manner entirely different from the procedure of the Act of Sederunt.

The application of fiars prices for payment of stipend of the parochial clergy was not invariable till the Act 48 Geo. III. c. 138 provided that stipend was to be converted into money at "the highest fiar prices." The term "highest" is applicable only when fiars are struck for more than one quality of grain; hence there is dissatisfaction amongst the clergy where only one quality of grain is valued. At the present date applications have been presented in a number of counties to the Sheriff to have two qualities fixed where it is the practice to have only one valued. In some cases (in Inverness and in Forfar) this has been successful, but the tendency of the Courts is undoubtedly against any alteration on the existing practice, and there is a heavy *onus* on the petitioners to show cause for the proposed change. An excellent statement of the reasons against change is given by the Sheriff of Roxburgh in a note to his interlocutor refusing the prayer of the petition (Feb. 1897, 4 S. L. T. No. 418). No doubt the diversity of practice is objectionable, but legislation would seem to be necessary to attain uniformity. Another objection is that the fiars prices are based on sales made during a part of the year only, and that when prices are probably not at the highest. In England, under the Tithe Commutation Acts, one set of values for the whole country is fixed by the

Land Commissioners, and is based on an average of the preceding seven years.

[*Histor. Acc. of Fiars*, a pamphlet by George Paterson (1851); *Fiars Prices*, by W. Hector; *Position of Fiars Prices; Conversion of Grain Payments*, Nenion Elliot; Ersk. i. 4. 6; Hunter, 2. 273; Connell on *Tithes*, i. 431; Barclay, *Digest*, *s.v.*]

Field Draining.—*See* Draining.

Finger-and-Toe (*Plasmodiophora brassicæ*).—This disease is undoubtedly one of the most destructive pests which the growers of swede and turnip crops on many classes of soil have to contend with. The swede and turnip crops are of outstanding importance in the economy of the farm, particularly in the more northerly parts of the kingdom, where, on account of the lower temperature and lesser sunshine, the mangel and kohl-rabi crops, which are not subject to this pest, cannot be advantageously grown. In these parts, therefore, the swede and turnip crops furnish the staple winter food for the cattle and sheep stocks, so that the loss resulting from the crops being ravaged by a disease, such as this, is often very severe.

Finger-and-toe—which is often known as Anbury—is a germ disease. It is due to the presence in the soil and the roots of a slime-fungus called *Plasmodiophora.* Dr. Marshall Ward in his standard work, entitled *Disease in Plants*, refers to it as follows:

"An equally remarkable example [of stimulation of cell activity] is that of *Plasmodiophora*, the amœboid naked protoplasm of which lives and creeps about in the protoplasm of a cell of the root of a turnip to which it gains access through the root hairs. It does not kill the cell, but stimulates its protoplasm to increased activity and growth and division, itself dividing also and passing new amœbae into each new daughter cell of the host. Here the processes of stimulation, hypertrophy, and further division are repeated, until hundreds or thousands of the turnip root cells are infected. The externally visible result is the formation of distorted swellings on the root (finger-and-toe), most of the cells of which are abnormally large and filled with amœboid *Plasmodiophora* protoplasm, which finally devours the turnip protoplasm, and itself passes over into spores. Here we have most convincing proof of the stimulation of protoplasm by other protoplasm in direct contact with it; and that the metabolism of the host cells is profoundly altered, is shown not only by the abnormal growth of the cells, but also by the starvation of the rest of the turnip as the *Plasmodiophora* gets the upper hand. We have here, in fact, a local intra-cellular parasitic disease gradually invading large tracts of tissue, and eventually inducing general disease resulting in death—a state of affairs reminding us of cancer in animals."

In regard to the above quotation, it may be pointed out that every attack of the disease does not result in the death of the plant. On the contrary we frequently find fairly well grown swedes and turnips which show the characteristic "distorted swellings on the roots," but otherwise present the appearance of being perfectly healthy. In other cases where the attack has been very virulent, and the resistant power of the plants has been less, many of the plants are killed off by the disease at a comparatively

early stage in the growing season. As a matter of fact, therefore, there are all degrees of virulence between these two extremes.

But although the *modus operandi* of the *Plasmodiophora* attacking the turnip has been thus lucidly described by Dr. Marshall Ward, yet the disease otherwise has always been somewhat of a mystery. For instance, it is often found that, on disease-infested land, that part of the crop which was seeded down the one day may be quite free from the attack of the pest, while the adjoining part, which was sown down a day later, or several days later, and getting the same treatment in every way, as well as being sown with seed from the same bag, may be very badly attacked. In the same way the disease had frequently appeared on land which had previously lain under grass from time immemorial. On account of these apparent vagaries on the part of the disease, our agricultural scientists as a rule have fought shy of searching for a remedy against it; and although the loss annually caused by the disease has been serious, yet up to this date we are unable to point to any exhaustive series of experiments that has been conducted at any collegiate centre by way of discovering a method of prevention. But those who have to contend with the pest have tried all manner of remedies against it, and from the experiences of practical farmers, quite as much as from isolated experiments and observations made by scientists, a number of important facts respecting this disease have been brought to light. These facts we now proceed to set forth.

Finger-and-toe is never found on clay soil. It is a "free" soil disease, and it is generally found in its most virulent form on light and "hungry" soils, though occasionally a bad attack of it may be seen on very rich and loamy soil in high manurial condition. The fact that clay soils are immune to the disease seems to point to potash as being one of the elements to be used as combating the pest, clay soils having generally a large percentage of potash, though frequently in a form which is not readily available to the plant. Neither is the disease ever found on calcareous soils, that is to say, on soils which are heavily charged with lime. This fact points to lime as being a preventive of the disease, and mostly all writers on the subject have expressed the opinion that lime is the best remedy against the pest. Thus Dr. Marshall Ward in his work on *Disease in Plants* says: "Finger-and-toe, due to *Plasmodiophora*, has been successfully dealt with by the application of lime; but we do not know whether the effect is owing to indirect action on the soil, to direct action on the plasmodia, or to the increased production of root hairs caused by liming." Undoubtedly a heavy dressing of lime did mitigate the pest, though it certainly did not in every case prevent it. The lime was usually applied in the form of quick-lime to the soil immediately after a diseased crop of roots had been taken off, the idea being that the hot lime being thus brought in contact with the disease germs would inevitably kill them. But in recent years this method of treatment has been in large measure abandoned for economic reasons. The large dressing of quick-lime would no doubt kill most of the disease germs, but it would also kill off a large proportion of the nitrifying and other advantageous soil germs as well: and if there be one fact which has been more clearly brought out than another by the scientific experiments of recent years, it is the fact that large dressings of quick-lime were unprofitable. Fortunately agricultural science was able to show that small dressings of quick-lime ground to a fine powder, and applied at frequent regular intervals, were much more effective, as these small dressings of ground lime could be very equally distributed over the soil by means of the manure distributor; and from the

small quantity applied at any one time—up to 20 cwts. per acre as a maximum—and harrowed in as soon as applied, the lime was rapidly converted into carbonate of lime, which was essential to the due action of the nitrifying and other advantageous soil bacteria. The lime also served to correct any acidity in the soil—except in the case of water-logged or wet and undrained soils. This method of applying lime has been largely practised in recent years, and has been found very successful in mitigating the pest, but other things have to be considered as well as lime in the growing of a good sound healthy crop.

Acidity in the soil, or in the manures applied to the soil, also has a marked effect in the way of encouraging the disease. This fact has been fully recognised by agricultural scientists in recent years. The drainage of wet land has therefore to be carried out before the disease can be got rid of. In the same way the Board of Agriculture in one of their leaflets, which are gratuitously distributed among farmers all over the country, put it on record that manures which had been dissolved in sulphuric acid had a marked tendency to encourage the disease. In soils, therefore, which are liable to become infested with finger-and-toe, it is most desirable that such manures as dissolved bones and superphosphate should be avoided at least for the turnip crop. Bone flour, bone meal, fermented bone meal, ground coprolites and basic slag may be safely used—the bone manures referred to supplying nitrogen as well as phosphates, while the basic slag supplies lime compounds as well as phosphates. In this connection it should also be noted that nitrate of soda, or any other very active nitrogenous manure, should be used sparingly and with great caution on finger-and-toe infested land. Such manures may be used freely and advantageously wherever there is no reason to dread the pest, but owing to their forcing on a rapid flush of growth for a time they should be used with great caution on land that is subject to the pest.

Great care should also be taken in the cultivation of the soil. Every care should be taken to avoid cultivating or carting on the soil in wet weather. It frequently happens, however, that in unfavourable and backward seasons it is all but impossible to avoid doing this, but the crop suffers in consequence. It is also most desirable that land which is subject to the pest should get as little working after being ploughed as possible, provided a good tilth be got. In cases where the land is foul a good deal of cultivating is often necessary, and in most cases it is desirable that the soil which has been repeatedly torn with cultivators and harrows, should be allowed to lie for a week or ten days before being seeded. But here again the exigencies of the season have to be reckoned with, and the grower is often forced, through stress of weather and pressure of work, to adopt a course which he knows to be of doubtful wisdom.

Many farmers have been forced through the losses caused by this pest, and other causes as well, to lengthen their rotation of crops by leaving the land longer in grass. This lengthening of the rotation increases the interval between the times when the land is under root crops, and, as its advocates say, it gives the germ of the disease a chance to die out. This plan, however, is not in every case successful, for, as above noted, the disease frequently makes its appearance after very long intervals, and it has even been found on soils that had been ploughed out of pasture which had never before been broken within the memory of man. It is very difficult to say why such should be the case, but some facts may be stated which may help to explain these mystifying points. For one thing, it has to be remembered that the germs, or their spores, of the disease are

not destroyed by passing through the alimentary track of any animal. If, therefore, a crop of roots be manured with dung made by the consumption of infected roots, it is only to be expected that the soil will be infected in this case. For another thing, road scrapings from roads along which cattle or sheep are driven to market may spread the infection, and cattle, sheep, horses, carts and men passing along these roads may inoculate the soil with the germs taken from these roads. For another thing, it is a known fact that all plants of the cruciferous order are liable to take this disease, and that the charlock, which is so frequently found growing amongst the corn and green crops, is a plant which is very liable to the disease, and acts as a host-plant in the way of perpetuating the germs. Fortunately science has discovered a means by which charlock may be destroyed by spraying (*see* Spraying), and therefore it is most important that this pernicious weed should, as far as possible, be eradicated, particularly on land that is infested with this pest. The plan of lengthening this rotation, however, is also open to the objection that it makes for rural depopulation, as there is a great reduction of the labour employed on the farm when land is laid down to pasture for a period of years instead of being kept regularly under arable crops. In fact, that plan is rarely adopted except in districts where, through long distances from a favourable market, or from a shipping port, potatoes are not grown to any large extent.

This fact brings us to a most important point in considering the best remedy against the disease. It is a well-known fact that the growing of a crop of potatoes on any land has the effect of practically making the land immune against the disease for a time. Why that should be the case is a point that science cannot at present explain. Some have argued that as potash is the " dominant manure " for potatoes, the effect in question may be due to the liberal dressing of potash usually given to the potato crop. But this explanation is not satisfactory, for occasionally crops of potatoes are grown with dung alone, and without the application of any artificial manure at all. Besides, potash of itself is not a remedy against the disease, though it is an essential element in any system of manuring designed to check the spread of the disease. But the fact remains that growing a crop of potatoes on any land renders the land practically immune against the disease for a rotation of cropping. Indeed, those who are extensive growers of potatoes, so that they have a crop of potatoes between each crop of roots on the same land, have rarely much trouble with this disease, provided that due care is taken to prevent their land being infected in any of the ways above referred to.

While, therefore, there is much about the disease which cannot be satisfactorily explained, yet there are some facts known which may enable the growers of roots on infected soil to reduce the mischief wrought by the disease to very small compass. The old idea as to the application of lime being the best remedy against it had a certain amount of truth in it; but, as has been shown above, other things besides lime require to be considered if the grower is to produce a crop of sound roots on infected soil. The heavy dressings of lime which were commonly applied to the soil in former times, have now been generally superseded by the newer and more rational plan of applying a much smaller dressing of ground lime. Potash—preferably kainit in the case of the root crop—must also be applied with a liberal hand while phosphates, which have been dissolved in sulphuric acid, must be withheld; and active nitrogenous manures, such as nitrate of soda, or, in a lesser degree, sulphate of ammonia, must be applied sparingly and with caution. Great care must be taken

to avoid cultivating the land when it is wet. Care should also be taken to have the charlock destroyed when growing among grain crops, as it is a host-plant which is liable to become diseased and to keep on the infection. The plan of lengthening the rotation by leaving the land longer under grass, though not in every case an absolute success, is fairly effective in combating the disease, but is open to the objection of causing rural depopulation. But if the system of treatment above described be carefully adhered to, the ravages of the disease will be greatly mitigated, if they be not done away with altogether.

Fir.—The firs are coniferous trees of the tribe *Abietineæ* (*see* Conifers) comprising the genera—(1) *Picea*, the Spruces; (2) *Abies*, the Silver Firs; (3) *Pseudotsuga*, the Douglas Fir; (4) *Tsuga*, the Hemlocks; (5) *Larix*, the Larches; and (6) *Pseudolarix*, the Chinese Larch—an exceedingly important group, whether to the forester or the arboriculturist. The numbers of known species of *Picea* and *Abies* is so great that notice will be made here only of those which are likely to prove of economic value and adaptability to British forestry, or are desirable for their ornamental character. Several which possess no particular qualities to recommend them either for profit or ornament, may be omitted. There is no species of fir indigenous to the British Isles; the planter, therefore, has to make his choice among the exotic species.

(1) *Picea*, the Spruces.—"The leading characteristics of the spruce firs are: projecting cushions at the base of the *leaves*, giving a rough, pegged appearance to the shoots; four-sided leaves (flat in the section *Omorika*), uniform in structure; woody *cones*, usually pendulous, ripening in the first year, the scales not falling away from one another as in the silver firs (*Abies*). *Bracts* concealed, not projecting, free from the scales except at the base. *Stamens* in spike-like masses. *Anthers*, two-lobed, apiculate. *Pollen-cells* winged. *Seeds*, small. *Seed-wings*, obovate, separable, covering the upper side of the seed. *Cotyledons* 8–10, three-sided, toothed, primary leaves flat, denticulate" (Masters).

The spruces (*Picea*) are ranged botanically in two groups by the character of the leaves: (*a*) *Eupicea*, the true spruces, needles four-sided and four-angled, with stomata on all four surfaces; ripe cones always pendulous; (*b*) *Omorika*, the flat-leaved spruces, needles two-sided, with stomata only on the dorsal surface; ripe cones pendent, horizontal, or erect (Wilkomm).

(*a*) *Eupicea*, the True Spruces:

The Norway Spruce (*Picea excelsa*, formerly *Abies excelsa*).—"*Leaves* scattered, solitary, four-sided, deep sombre green, curved, stiff, sharp-pointed, more crowded laterally than on the upper and under sides of the twigs, nearly 1 inch long. *Cones* on the point of upper branches, pendent when full grown: 5 to 7 inches long, $1\frac{1}{2}$ to 2 inches broad. *Seeds* very small, with a wing $\frac{3}{4}$ inch long. Cotyledons 7–9" (Gordon).

A lofty evergreen tree indigenous in the mountains of France and Northern Spain, extending eastwards across Europe to Northern Asia and northwards to Scandinavia. Introduced to Britain about the middle of the sixteenth century, it has been more extensively planted than any other conifer except the larch. In sheltered mountain glens it attains a height of 150 to 160 feet, the tallest British-grown spruce reported to the Conifer Conference in 1891 being 132 feet high, with a girth of $12\frac{1}{2}$ feet, at Studley Royal, Yorks.

Spruce timber is imported into Britain in large quantities from the Baltic under the names of "white Norway," "white fir," "Danzig deal," etc., and is much used in house-building, scaffolding, pitwood, and general carpentry. In this country the timber produced is generally coarse and knotty, owing to the practice of growing spruce in mixture with broad-leaved trees, when, being a shade-bearer, it retains its lower branches. It should therefore be planted pure, not more than 4 feet apart, and very sparingly thinned. It prefers a moist mountain soil, but thrives well also in the plains on a free, deep soil. It is a mistake commonly made to plant it in wet, peaty hollows, for, although the plants may grow vigorously for some years in such situations, they invariably pine before reaching maturity, and yield timber of inferior quality. In forming a spruce plantation, protection should be given against cold and violent winds, or salt-laden blasts from the sea, for it is a tree very impatient of both. A windbreak of at least 50 yards should be planted with Scots or Corsican pine, or a mixture of these with beech, ash, and sycamore. Probably, however, British planters will find it to their profit to discard Norway spruce altogether in favour of Douglas fir, giant cypress, Sitka spruce, and perhaps *Picea ajanensis*, for there can be no doubt that Norway spruce attains its best development when it has more perfect and constant winter rest than our climate can give it. Cheapness and ease of handling in a young state are its chief recommendations, but the other species mentioned are quite as manageable, and could be produced by nurserymen at as cheap a rate as the other if the demand were as regular.

Continental foresters generally work spruce on a sixty to ninety years' rotation. The trees are propagated from seed, which should not be sown thickly, as the seedlings are of slow growth, and should not be moved till two years old. They are not ready for planting out till they are five years old, when they take hold readily and make annual growths of 2 or 3 feet. Although the Norway spruce ripens seed regularly in Britain, there is no instance recorded of natural regeneration there.

The commercial products of spruce, besides the timber, are "spruce rosin or frankincense," whence Burgundy pitch is prepared, and pulp wood for paper-making and cellulose. Spruce beer is the malt liquor to which a decoction of buds and cones has been added before fermentation; and it is said that the Norwegian peasants, when meal runs short, pound the sweet inner bark of this tree and add it to the paste, whence *fladbrod* is baked.

The Oriental Spruce (*Picea orientalis*) bears a general resemblance to the Norway spruce in form and colour, but is said not to attain a greater height than 70 or 80 feet, and the branchlets are far more delicate in outline than in the northern species, with the leaves set very densely, of a deep, shining green. This tree forms pure forests on the eastern coast of the Black Sea in Upper Mingrelia and near Tiflis, the timber produced bearing a high reputation for toughness and elasticity. No attempt has been made in Britain to test its commercial value; but it is probable that, owing to its perfect hardiness and lateness of starting in spring it is well adapted for planting in exposure which the Norway spruce would not endure. Some foresters have complained that its growth is slow; but it may be relied on to increase in height at the rate of 1 to 1½ foot each season. As a decorative subject, it has no superior among the spruces, feathering beautifully to the ground and retaining its dense rich verdure throughout the year. Propagation as for Norway spruce, than which it is hardier at all stages. The largest British specimen reported in 1903 is

one in Carnarvonshire, which was then 75 feet high and 6¼ feet in girth, aged fifty-two years.

Besides these two spruces, there is probably none other of the *Eupicea* section worth attempting to cultivate for profit in Britain; but there are many species which deserve attention for their purely ornamental qualities. Chief among these is the Himalayan Morinda (*P. Morinda* or *Smithiana*), a superb tree, hardy in Britain, but requiring shelter from violent winds. It has heavy, plume-like, drooping branchlets, and produces a soft perishable deal. Of the American species, the blue spruce (*P. parryana* or *pungens*) is often planted in pleasure grounds, especially the variety with very glaucous, almost blue foliage; but it is only ornamental in youth, as it becomes ragged and bare below on approaching maturity. Engelmann's spruce (*P. Engelmanni*) produces valuable lumber in North America, but suffers in Britain from spring frost.

(*b*) *Omorika*, the Flat-leaved Spruces:

THE SITKA SPRUCE (*Picea Sitchenis*, Carrière, formerly *Abies Menziesii*). —"*Leaves*, solitary, thickly scattered on the young shoots, narrow, linear, rigid, sharp-pointed and incurved, rich, vivid green above and quite silvery below, ¾ to 1 inch long, soon falling off after the first season, leaving the old branches very naked, warted, and with a jointed appearance. *Buds*, ovate-pointed and covered with resin. *Cones*, 3 inches long and 1 to 1¼ inch broad, pendulous, cylindrical, blunt-pointed, the scales loose and not compact; *bracteas*, small and hidden in the scales; *seeds*, very small and winged" (Gordon).

The Sitka spruce, or Menzies spruce as it was named by Douglas, who brought it to this country in 1838, seems destined to supersede all others of the genus for profitable planting in Britain. It forms forests in North California, Sitka Island, and Shasta, where it reaches a height of 200 feet, with 100 feet of clean bole. It ascends the Rocky Mountains to the 7000 feet level, and in rapidity of growth nearly, if not quite, equals the Douglas fir. A Sitka spruce was reported from Perthshire to the Conifer Conference of 1903 as 111 feet high and 13⅓ feet in girth at fifty-eight years of age. The timber, grown in America and in Germany, is light reddish-brown, of excellent quality and durable. No opportunity has been given of testing British-grown timber, for the tree, being a shade-bearer, unless grown in close forest, throws out long and strong side branches, destroying the quality of the bole. But it has already proved itself more enduring of cold winds than the Norway spruce, less particular as to soil, and certainly should be grown in preference to that species. At present, the price charged for young plants in this country is almost prohibitive, but seed can be obtained at a very cheap rate in most seasons, and is very easily raised. Two-year-old seedlings, also, are supplied by continental nurserymen at a moderate price, and British firms will doubtless follow suit when the demand justifies a large stock being raised. Propagation, as for the Norway spruce. The young trees, at four or five years, twice transplanted, should be planted pure at 4 feet × 4.

As an ornamental tree the Sitka spruce ranks low; the habit of shedding its leaves giving it a thin and ragged appearance, which is not noticed when grown in close forest. It is said that its prickly foliage protects it when young from the attacks of deer.

THE SERVIAN SPRUCE (*Picea omorika*).—A tall, slender fir, said to grow 130 feet high, with a stem girth of only 4 feet (Elwes and Henry), with very short branches, giving the tree a more fastigiate outline than any other spruce. The male flowers are bright red and the cones when young

are bluish-black, dark brown when ripe, the upper ones being erect, the lower ones pendulous, and the intermediate ones horizontal. The Servian spruce was first discovered by Pancic in 1875, forming forests only in a small district in South-western Servia, strictly confined to limestone rocks from 2700 to 5300 feet elevation. In Britain, however, it grows vigorously on many varieties of soil, at least in youth, when its peculiar habit of growth and rich verdure makes it a very desirable ornament in garden or pinetum. It is not likely to be grown for any other purpose in Western Europe.

The Manchurian Spruce (*Picea ajanensis*).—"*Leaves*, flattened, thin, blunt or ending in a short point, slightly keeled on both surfaces; young leaves on opening slightly tinged with red; mature leaves green on ventral or upper surface, silvery white on dorsal or lower surface, with two broad bands of stomata. *Cones*, purple when young, brown when ripe, straight, tapering at each end, 2 to 3 inches long, 1 inch wide; *seed*, winged. *Branchlets*, glabrous, yellow, never becoming reddish" (Elwes and Henry).

This fine spruce forms forests in Manchuria, Saghalien, Amurland, and Eastern Siberia, growing 100 to 150 feet high, and bears a general resemblance to the Sitka spruce. It is often confused with the Hondo spruce from Japan (*P. hondoensis*), from which it may be distinguished by the colour of the branchlets, which become reddish in the second year in *P. hondoensis*, but retain their yellow colour in *P. ajanensis*. It is also confounded with *P. Alcockiana*, which has tetragonal needles, whereas *P. ajanensis* has flat leaves.

The Manchurian spruce has not been long enough in cultivation in Britain to test its qualities as a timber tree, but the exceeding vigour of young plants, which increase 3 feet in height annually, seem to indicate a valuable addition to our forest resources. It is perfectly hardy, and very ornamental as a young tree. It appears to be indifferent as to soil, growing naturally in cold marshy land at the sea-level, and rising to an altitude of over 1000 feet inland. Mr. Elwes, who passed the night in a forest factory in Hokkiado, where the timber of this spruce was being worked for export, reports the deal as soft, light, and fine-grained, "probably as good as that of other spruces." The Hondo spruce (*P. hondoensis*) is closely akin to the Manchurian spruce and of equal promise as a forest tree in Britain. Propagation of both species as for the Norway spruce.

(2) *Abies*, the Silver Firs (formerly *Picea*).—"Trees with whorled branches, adult leaves two-ranked, sessile, flat, leaving a circular scar on the branch when they fall. *Male catkins* scattered, axillary; anthers crested, opening crosswise; pollen-cells winged. *Cones* erect, maturing the first year. *Bracts* more or less conspicuous, free from the scales except at their base, seed-scales becoming detached from a central column when ripe, and each falling separately. *Seed* with a large, inseparable wing. *Cotyledons* 4–8, flat, leafy, entire. *Primary leaves* of the same order, but much smaller" (Masters).

Wilkomm enumerates thirty-three known species of silver fir, namely, five European, fourteen Asiatic, one African, and fifteen North American (though of the last Sargent recognises only nine). Of the Asiatic species, one is common to Europe, as is also the solitary African species, *A. Numidica*.

The Common Silver Fir (*Abies pectinata*).—"*Leaves*, solitary, flat, obtuse, two-rowed, with turned-up points, from $\frac{5}{8}$ to $1\frac{1}{2}$ inch long, stiff, shining dark green above, with a line of silvery white on each side of the midrib beneath. *Cones*, 6 to 7 inches long, $1\frac{1}{2}$ to 2 inches broad, cylindrical, erect, on the upper side of the branches, brown when ripe" (Gordon).

The silver fir is the loftiest European forest tree, attaining a height of 200 feet, and capable of yielding a greater weight of timber per acre than any other tree indigenous to Europe; perhaps the Douglas fir and Sitka spruce are the only conifers that surpass it in the latter respect. It is a native of a wide range of country, extending from the Pyrenees across Central and Southern Europe to Western and North-western Asia, rising on the Alps to an altitude of 4000 feet. Introduced into Britain about 1603, it has proved perfectly hardy there, although liable when young to sharp set-back from late frost, unless protected by older trees. Being a shade lover, it is one of the best subjects for underplanting light-demanding trees, but it has never found with British foresters the favour due to its excellent qualities, owing to faulty practice in planting. It is commonly seen growing at wide intervals in mixed high wood, which it soon outstrips, and its top gets ruined by storms, while its lower branches grow strong and close, creating coarse, knotty timber very difficult to work. But in the Vosges and the Harz Mountains, where this tree is grown close in pure forest, the boles are clean and very lofty, producing fine deals, which, although reputed to be inferior in durability to Norway spruce, command a ready and regular market throughout Central and Southern Europe. The bark yields a fine resin, the source of Strasburg turpentine and Burgundy pitch.

Planted densely, the silver fir is admirably suited for a windbreak, resisting storms and sea exposure, provided it has the support of its own species in close company. It is very indifferent as to soil, provided that it be well drained; but it is very impatient of stagnant water in soil or subsoil. Usually it is very free from disease and parasites, but in many parts of the country, especially the north-east of Scotland, it has suffered very seriously of late years from the attacks of aphides. As an ornamental tree, it is hard to beat for majesty and grace, especially when grown in groves or avenues. The largest specimens reported from the United Kingdom in 1891 were respectively 111 feet high and 15½ feet in girth at 5 feet from the ground (Carton, Kildare), and 110 feet high, with a girth of 17¾ feet (Rossdhu, Dumbartonshire).

The silver fir is propagated from seed, but protection must be given from frost. Otherwise the treatment is the same as for Norway spruce, and the young trees will be ready for planting out at five years old; but they are so sensitive to late frost that it is best to let the ground be planted two years previously with larch, or else to plant the silvers under old broad-leaved trees, other than beech, which have either been over-thinned, or which it is intended to remove in rotation. Unlike the spruce, this tree, and several other silver firs, such as *A. Webbiana*, *nobilis*, etc., will propagate themselves spontaneously from seed in British woodlands, where the undergrowth is not too dense, and where ground game does not abound.

None of the other European species of silver fir are generally suitable for British forestry, although *A. cephalonica* from the Grecian Archipelago is often grown for ornament. It thrives well in the warmer southern counties of England, where it has attained a height of about 80 feet, but dislikes a humid soil and climate. It produces excellent timber, hard and durable, in its native forests. *A. pinsapo* is a native of the Spanish mountains, differing from all other trees of this genus in the arrangement of its short, thick, sharp-pointed leaves, set closely at right angles all round the branchlets. It is only suitable for ornamental work in this country, and that in the southern counties on dry soil. In

the Crimean silver fir (*A. Nordmanniana*) it appeared at first that we had a valuable tree for British forestry, and it was planted more extensively than most other exotic conifers thirty or forty years ago; but it has not stood the test of our climate. Growing vigorously for the first twenty years, the young trees present a beautiful appearance, the regularly whorled branches being thickly clothed with flat leaves 1 inch long, deep, glossy green above and silvery below. Starting growth later than other silver firs, it escapes damage by spring frosts, but the almost universal experience has been that the majority of Crimean silvers succumb to attacks of aphis when between twenty and thirty years old. In the remarkable woodland at Benmore, Argyllshire, this tree was planted more extensively than any other conifer between thirty and forty years ago, but very few now remain. Those which do survive, at Benmore and elsewhere, form magnificent specimens, the largest reported in 1903, from Perthshire, measuring at forty-eight years old 75 feet high, with a girth of $8\frac{3}{4}$ feet. The failure of this fine tree is the more disappointing to British foresters on account of its perfect hardiness and the excellent quality of its timber.

Of the Asiatic silver firs it cannot be said that any one has given indication of becoming a valuable forest tree in Britain, although several species are hardy, and exceedingly beautiful when well grown as specimens. *A. firma*, introduced in 1861, though one of the finest of Japanese conifers, seldom succeeds in this country. *A. Veitchii*, also from Japan, where it grows 120 to 140 feet high, was brought to Britain in 1879, and takes kindly to our soil and climate, but is not likely to supplant the common silver fir, which it nearly resembles. *A. Pindrow*, from the Eastern Himalayas and Japan, is a grand fir, but too susceptible of late frosts to be relied on as a British forest tree. The same may be said of *A. Webbiana*, from the same region. Both these trees grow at an elevation of 10,000 feet and upwards; the result of bringing them down to near sea-level is to cause them to start growth prematurely in spring, when they are sure to suffer. It is worth an effort, however, to grow a few of these fine silvers for ornament, because of their splendid foliage, the leaves being from $1\frac{1}{2}$ to $2\frac{1}{2}$ inches long, with under-surfaces of gleaming silver. The best chance for them (and this applies to many high-level conifers) is to plant them on a north exposure, shaded from the morning sun.

The North American species of *Abies* find greater favour from arboriculturists in this country than from practical foresters. According to Sargent, these magnificent and beautiful trees are of little account as lumber, the timber of most of them being soft, coarse, and perishable. He makes an exception in favour of *A. nobilis*, a tree ranging southwards from Washington to Oregon at an elevation of 2500 to 5000 feet, and attaining a height of 150 to 250 feet, the deal of which he describes as "light, hard, strong, rather close-grained, pale brown streaked with red." No exotic tree has taken more kindly to the conditions of the United Kingdom than this beautiful fir, which springs readily from self-sown seed, and is of very rapid growth. It has been extensively planted for ornament since its introduction in 1831, and many British-grown specimens now exceed 80 feet in height. At Ballindalloch, in Banffshire, there is a specimen, planted in 1860, measuring, in 1907, 94 feet high and 10 feet in girth. But, like the common silver fir and others of this genus, it has seldom been tried under forest conditions. It outgrows the surrounding wood, and then the top shoot perishes from exposure, inducing precocious and excessive fruiting, which saps the vitality of the tree. At Benmore,

in Argyllshire, where it is grown in masses with Douglas fir and *Thuya plicata*, it maintains perfect vigour and health, without any tendency to precocious coning. It may probably be grown with profit as pure high wood, or mixed with larch; but it should be noted that, like all the genus except the common silver fir, it will not endure shade.

The loftiest silver fir in America, indeed in the world, is *A. grandis*, which grows naturally near the coast from Vancouver Island to Mendocino County, California, and in the mountains of Northern Washington and Idaho to Eastern Oregon, rising to an altitude of 7000 feet, and attaining a stature of 250 to 300 feet. It is a beautiful tree, in general appearance very like the common silver fir, and seems perfectly at home in Britain, whither Douglas sent the first seeds in 1831, and where it has already grown to between 90 and 100 feet high; but as a forest tree it is not valuable, the timber being neither strong nor durable. The same may be said of *A. lasiocarpa* and *A. concolor*, lovely ornaments in a park, but economically of little value. *A. amabilis*, a tree growing 250 feet high in British Colombia and Oregon, produces better timber than the three species last named, and is one of the loveliest of firs, being of columnar habit with very white lower surfaces to the leaves. Even more beautiful is *A. magnifica* with very glaucous young foliage, turning blue-green when mature. It is very abundant on the Sierra Nevada, attaining an elevation of 10,000 feet and a height of 200; but its timber is inferior in quality to that of *A. amabilis*.

Of *A. bracteata*, a silver fir from the Santa Lucia range in Southern California, Sir Joseph Hooker wrote when it was introduced in 1852, that "perhaps the introduction of no conifer, not even that of the Deodar, has excited a more lively interest in horticulture and arboriculture than that of this species with its porcupine fruits." The abundance of resin in the wood of this tree indicates durability, but it can never be of more than arboricultural interest in this country, owing to its sensitiveness to late frosts. It derives its specific name *bracteata* from the spine-like bracts which project 2 inches beyond the cone-scales, giving the cone a very curious appearance. It is known in America as *A. venusta*, and is said to prefer a limestone or chalk formation.

In propagating these American silver firs, and others which have not been mentioned, the seed should be sown in cold frames to protect them from frost. The best of them should certainly be cultivated by the arboriculturist on account of their exceeding beauty, but probably none of them, if it be not *A. nobilis*, and none of the Asiatic species, are fitted to take the place of the common silver fir of Europe as a British forest tree.

(3) *Pseudotsuga*, the Douglas Firs.—This genus, formerly reckoned among the spruces, contains only two species (some botanists admit only one) having points in common with the spruces, the silver firs and the hemlocks. Only one of these species or varieties concerns British planters, and it does so in a very important degree, for the introduction of this tree in 1828 marked what will probably prove a revolution in forestry management.

THE DOUGLAS FIR (*Pseudotsuga Douglasii*, Carr.; *P. mucronata* of Sargent, formerly *Abies Douglasii*).—"A tree often 200 feet high. *Leaves*, straight or rarely slightly incurved, rounded and obtuse at the apex, or acute on leading shoots, $\frac{3}{4}$ to $1\frac{1}{4}$ inch long, $\frac{1}{16}$ to $\frac{1}{12}$ inch wide, dark yellow-green, rarely light or dark bluish-green, usually persistent until their eighth year. *Flowers*, staminate, orange-red; pistillate, with slender elongated bracts

deeply tinged with red. *Fruit*, pendent on long, stout stems, 2 to $4\frac{1}{2}$ inches long, with thin, slightly concave scales, rounded and occasionally somewhat elongated at the apex, usually rather longer than broad; when fully grown at mid-summer slightly puberulous, dark blue-green below, purplish towards the apex, bright red on the closely appressed margins, and pale green bracts becoming slightly reflexed above the middle, $\frac{1}{5}$ to $\frac{1}{4}$ inch wide, often extending $\frac{1}{2}$ inch beyond the scales. *Seeds*, light reddish-brown and lustrous above, pale and marked below into large irregular white spots, with wings about the same length as the seeds" (Sargent).

This grand tree, which extends all through the Rocky Mountains to an elevation of 5500 feet, is found in greatest perfection near sea-level in Southern British Colombia, Washington, and Oregon, where it is often 200 feet high. The timber is light red or yellow, of excellent quality, largely used by builders and for a variety of purposes, and exported under the trade name of Oregon pine. It thrives as well in Britain as in its native forests, having already attained a height of 130 feet in several counties of the three kingdoms.

There are two main varieties—a dark green kind from Oregon and the Pacific coast and a light green or glaucous kind from the mountains of Colorado. Care should be taken to obtain seed or plants only of the first named, which experience has proved to be best adapted for the humid atmosphere of these islands. Planted as specimens, or distributed at wide intervals in mixture with other trees, the Douglas fir has shared with other fine exotic species the evils of mismanagement. A shade-bearer, its timber is ruined with coarse knots if it is not planted and grown in close forests of its own species; and as it rapidly outpaces every other tree in upward growth, except the Sitka spruce, it is soon deformed by gales unless it is planted in mass. What it might be as a timber-producer if rightly treated may be seen from the following example, in which, although the trees were not properly managed, is evidence of the commercial capacity of British-grown Douglas fir.

In 1860, 8 acres were planted at Taymount with 2416 Douglas fir, four years old, raised from seed of the parent trees at Scone, together with 7264 larch, being 302 Douglas and 908 larch = 1210 trees per acre. The land being level, these trees must have been set at 6 feet apart, which any forester will perceive was far too wide planting. In 1880 all the larch had been cut out, and in 1887 the great mistake was committed of cutting out 620 Douglas firs, which were sold for £34. The remaining 1796 trees threw out strong side branches, to the great detriment of their timber. Nevertheless, in 1900, forty years after planting, a Perth wood merchant offered 9d. a foot for the lot standing, the price current for larch being 1s. and for Scots pine 6d. a foot. This offer, which was not accepted, amounted to £1600 for the crop, or £200 an acre, representing a gross annual rent of £5 an acre during the forty years of growth. Deduct grazing rent and all expenses, with compound interest on capital locked up, but add the price of thinnings (which should never have been made), and the profit is a very handsome one. At present, British planters are afraid of Douglas fir, because they have not learnt how to manage it; but light is beginning to dawn upon our insular minds, and several landowners are leading the way with extensive plantations of this valuable tree.

The Douglas fir is such a robust tree when grown in a humid atmosphere, such as that of Ireland and Western Britain, that it may be reasonably expected to resist fungoid disease and insect parasites. But it parts with much of its vitality on limestone and chalk, or on any hot soil in dry

atmosphere, and is then subject to attack from the fungi *Botrytes cinerea* and *Phoma pithya.* Though a shade-bearer, inasmuch as it will endure any amount of side shade, it cannot bear the drip of overhanging trees, wherefore it should only be used for underplanting in very open woods averaging not less than 60 or 70 feet high. It will overtake these in thirty to forty years, when the whole wood should be felled together, as the Douglas would deteriorate or be blown down if left standing after removal of the older trees. The right management is to plant pure, 4 feet × 4, on plain or mountain up to 600 feet, in sufficient mass to secure resistance to wind. Thinning, if undertaken at all, should be confined to removing suppressed trees, but should never be carried so far as to allow the formation of side branches.

Hitherto Douglas fir has been remarkably immune from parasites in the western and northern districts of Britain, where there is enough humidity in soil and atmosphere to keep the trees in vigorous growth. But there has appeared lately in the plantations at Durris on Deeside large numbers of a hymenopterous insect, *Megastigmus spermotrophus*, one of the *Chalcididæ*, which are usually parasitic upon other insects. Mr. Crozier, forester of Durris, having, in May 1905, found hundreds of these little flies escaping from the seeds of Douglas fir and finding their grubs in other seeds, sent specimens for verification to Mr. MacDougall, consulting entomologist to the Scottish Arboricultural Society. The closest scrutiny did not reveal traces of any other insect having been in the seeds, and the conclusion arrived at was that the *Megastigmus* had destroyed them. Mr. Crozier had been accustomed to collect over 300 bushels of Douglas fir seed in good seasons, but in 1904 the cones were so much infested with grubs of *Megastigmus* that they were not worth harvesting.

Douglas fir ripens seed plentifully in Britain, beginning at twenty to twenty-five years old, and Oregon or British Columbian seed can be had of warrantable quality from certain continental firms at a very cheap rate. Sow as directed for Norway spruce, but give the seedlings more room when transplanted, as the growth is much more rapid than that of any spruce. On ground prepared by ploughing, or on naturally bare land, three-year-old plants may be put out, but where the herbage is rank it is better to wait till they are four years old, once or twice transplanted.

(4) *Tsuga*, the Hemlocks (formerly *Abies*).—"Tall pyramidal evergreen trees, with deeply furrowed, astringent bark, bright cinnamon red, except on the surface; soft pale wood; nodding leading shoots; slender scattered horizontal branches, the whole forming graceful, pendent masses of foliage; a genus confined to temperate North America, Japan, Central and Western China, and the Himalayas" (shortened from Sargent).

Of the six species of *Tsuga* (seven according to Sargent) all are worth cultivating for their beauty, but only one, the Californian hemlock, has given indication of value to British forestry. The common hemlock, *T. canadensis*, has been commonly grown for ornament in Britain since its introduction in 1736, but it is so much inferior both in stature and quality of timber to the Californian species, that this should invariably be preferred, both for silviculture and arboriculture.

There is much confusion in the nomenclature of this genus, the Californian hemlock being usually named *Abies Albertiana* or *Mertensiana* in nurserymen's lists, while Sargent calls it *Tsuga heterophylla*, and applies the term *T. Mertensiana* to what English botanists call *T. Pattoniana*, an ornamental species with glaucous foliage.

The Western Hemlock (*Tsuga Mertensiana*, Carrière, formerly *Abies*

Albertiana).—" *Leaves* rounded at the apex, conspicuously grooved $\frac{1}{4}$ to $\frac{3}{4}$ inch long, $\frac{1}{16}$ to $\frac{1}{12}$ inch wide, dark green and very lustrous on the upper surface, marked below by broad white bands of seven to nine rows of stomata, and abruptly contracted at the base into slender petioles. Staminate *flowers* yellow; pistillate purple and puberulous, with broad bracts gradually narrowing to an obtuse point and shorter than their broadly ovate, slightly scarious scales. *Fruit*, pendulous at the ends of the shoots, oblong-oval, acute, sessile, $\frac{3}{4}$ to 1 inch long, with slightly puberulous scales longer than broad, often abruptly narrowed near the middle, and dark purple puberulous bracts rounded and contracted abruptly at the apex. *Seeds*, $\frac{1}{8}$ inch long, with occasional oil vesicles one-third to one-half as long as their narrow wings" (Sargent).

A beautiful tree, often reaching a height of 200 feet and ascending in Oregon to an elevation of 6000 feet. The timber is light, hard, and tough, pale yellowish-brown, much used by builders in America. The bark is excellent for tanning, and the inner bark is eaten by the Indians of Alaska. It is a moderate shade-bearer, carrying slender pendulous branches and forming one of the most decorative objects in park and garden scenery. It thrives well and grows exceedingly fast in Britain. At Hafodunos, near Abergele, a specimen fifty-four years old measured close on 100 feet high in 1906. But it has never been treated in close forest to test its timber-producing qualities. There is every probability that it might be profitably planted in the United Kingdom on good, fresh land, rather moist but well drained. Unfortunately, it strikes readily from cuttings, producing plants very inferior to those grown from seed sown in cold frames. Its subsequent treatment is that recommended for *Thuya plicata*.

The Mountain Hemlock (*Tsuga Pattoniana*, Sénéclause) is not such a lofty tree as the western hemlock, perhaps owing to its growing usually at higher altitudes than the other, although it descends to the sea-level in Alaska. It is a very ornamental tree, and perfectly hardy in Britain, but not likely to prove of the slightest economic value with us, the timber being very inferior to that of the western hemlock. At Murthly, in Perthshire, it had attained in 1906 a height of 47 feet, with a girth of 8, feet 8 inches. The Canadian hemlock (*T. Canadensis*, Carrière) is valueless for timber, though the inner bark makes excellent tanning material; as an ornamental tree it is far inferior to the two other species.

(5) *Larix*, the Larches.—Lofty deciduous trees, with awl-shaped, triangular, rarely quadrangular leaves, spirally scattered on leading shoots, but crowded into fascicles on lateral branches. Of the nine or ten known species, all are natives of the temperate zone in Europe, Asia, or America.

The Common Larch (*Larix Europæus*).—*Leaves* in wisps, tufts, or bundles, many together round a central bud, but singly on young plants and the leading shoots, deciduous, linear, soft, blunt or rounded at the points, spreading, slightly recurved and of a beautiful bright (grass) green. *Cones*, oval, erect, brown, 1 inch long, remaining long on the tree. *Scales*, persistent, roundish, streaked, slightly waved on the margins; bracteas generally longer than the scales. *Seeds*, small, with a broad wing; *seed-leaves*, 5–7 (shortened from Gordon).

Indigenous to the mountainous regions of Central Europe at elevations from 3000 to 6500 feet, the larch was first brought to England in 1629, but it was not until the second Duke of Atholl planted extensive tracts in the valley of the Tay during the eighteenth century that the extraordinary value of this tree began to be recognised.

The illustration on opposite page represents two larches at Dunkeld,

reputed to be the oldest in Scotland, having taken root on the rubbish heap where they had been thrown by the Duke's gardener in 1727, after an ineffectual attempt to grow them in a greenhouse. These trees, however, having been allowed to spread laterally, do not represent the erect and conical habit of growth which the species exhibits under forest treatment. The climatic conditions of the British Isles are so very different from those of the Alpine regions where the larch naturally grows, that it is surprising how well it has accommodated itself to the change.

Despite the effect of our dripping winters in causing a dangerous precocity of leafing and undue rapidity of growth in young trees, British-grown larch is not inferior to continental either in stature, bulk, or quality of timber. The largest specimen reported to the Conifer Conference in 1891 was a tree at Rossdhu, Dumbartonshire, 100 feet high and 10 feet in girth. Larch timber exceeds all other coniferous wood that can be grown in Britain in strength, toughness, and durability,

these qualities being present even in saplings of but few years' growth, which makes them readily saleable as fencing material, poles, etc. It is the favourite material for railway sleepers, telegraph poles, and pit-props; the average price it commands may be quoted at 1s. a cubic foot, or about twice that paid for Scots pine or spruce.

The chief requirements of the larch are light and free air—for it will not endure any degree of shade overhead—and a well-drained soil preferably sharp and somewhat light. When there is choice of exposure, a north aspect should be chosen, as less likely to encourage early leafing. Lastly, larch should always be mixed with other trees, whether broad-leaved or coniferous, even where it is intended to form the main crop. British planters, in their anxiety to produce the greatest possible weight per acre of this valuable timber, have fallen into the error of planting larch as pure forest, a condition in which it is never found growing naturally, and one which tends to encourage the spread of

the canker fungus *Peziza Wilkommii* or *Dasycypha calycina,* which has wrought so much havoc in almost all parts of the United Kingdom as to cause many landowners to discontinue the planting of larch altogether. Larch, ash, and Corsican pine form a very judicious mixture, their rate of annual growth being about equal, and, should the larch be attacked by disease, it may be cut out and the ash and pine be relied on for a crop. These three trees become commercially mature in succession—the ash at seventy to eighty years, larch at eighty to ninety, and Corsican pine at ninety to a hundred and ten. Beech and larch are a profitable mixture, the beech being a shade-bearer and the larch an imperious light-demander. A third mixture to be recommended is larch, sessile-flowered oak, and beech in equal proportions, care being taken that the larch does not overtop the oaks. All the larch will be felled at eighty to ninety years, leaving the oak and beech to mature a final crop. Another plan, recently adopted at Novar, is to plant pure with larch, and, when disease appears, cut out all the trees affected and underplant with *Thuya plicata*; but this seems open to the objection that a serious outbreak of disease is invited by affording facility for its rapid spread in pure larch forest. Seeing, however, that large areas have already been planted with pure larch, the proper course to take upon disease making its appearance, which is usually between the eighth and twenty-fifth year after planting, is to cut out every tree affected and to underplant with thuya, silver fir, or beech.

In districts where larch is liable to attack from aphis, beech is undoubtedly preferable for underplanting, because the larch aphis (*Chermes laricis*) is only a sexless form of two species of spruce aphis (*C. abietis* and *strobilobius*) which thrive on spruce and silver fir, whence they are readily transferred to larches.

In the summer of 1904 a very destructive foe to larch appeared in pure larch woods on the Mirehouse estate, Keswick. This is the large larch sawfly (*Nematus Erichsoni*), previously a rare insect in Britain, though known for more than sixty years as causing much damage in the Harz Mountains and in Denmark. In America the ravages of this insect were not noticed till 1882, since which date large areas of larch, both American and European, have been defoliated, many of the trees being killed, both in the United States and in Canada. The outbreak of 1904 in Cumberland was repeated and aggravated in the three succeeding summers, all trees in the affected area between twenty and seventy years being stripped of foliage by myriads of sawfly caterpillars. It was noted by Dr. Stewart MacDougall, when he visited the district in August 1906, that those larches which were planted pure, suffered worse than those mixed with broad-leaved trees. The myriads of caterpillars, covering lofty trees as well as low ones, render it hopeless to attempt to cope with the pest, which, as yet, seems to be confined to a considerable area in Cumberland. Should it spread, as is too probable, to other districts, it will afford additional reason for planting larch only in mixture with other trees.

The larch canker, its causes and possible remedies for it, have been the subject of much anxious inquiry and a immense deal of recent literature. The active agent in producing the canker is without doubt the fungus *Dasycypha calycina* (*Peziza Wilkommii*), which obtains entrance to the stem of the tree only through a wound or abrasure of the bark. The spores having germinated, slight swelling of the bark takes place, followed by a fissure, whence resin begins to flow. The fissures spread, the swellings increase, the outflow oxidises and appears as a black stain

on the stem, and small white cup-shaped bodies (ascocarps) with bright orange or yellow centres develop in the fissures. Meanwhile, the microscopic mycelium has been spreading through the cambium or inner bark, whence it penetrates into the sap-wood and heart-wood. The mycelium can only grow in winter when the tree is at rest; in summer the tree makes an effort to protect itself by interposing a layer of cork between the new bark and the bark which the fungus has killed; but the parasite evades this barrier by passing through the wood fibre to the healthy cambium beyond the cork; growth is entirely stopped in the affected part of the tree, but proceeds at more than normal rate in the healthy parts owing to the sap being diverted from the diseased part. Hence the cankered area appears as a depression in the stem, with a corresponding bulge on the opposite side of the stem, where the cambium continues to form broad annual rings.

Larch stems may be attacked at any age up to fifteen or twenty years; after that age the stem-bark appears to be strong and rough enough to resist invasion or to outgrow the intruder. Young branches in the crown of the tree may be attacked at any age, but no mischief ensues after the tree is, say, thirty years old, as the mycelium cannot readily find its way into the stem.

Trees from two to seven years planted usually succumb to the canker, dying at once when it embraces the whole circumference of the stem. After that age, where trees are growing vigorously under favourable conditions, a proportion of them overcome the attack and recover, although it is believed that they never get rid of the fungus. Hartig states that he has found larches in the Alps with the mycelium still growing, which the annual rings showed to have been active for a hundred years. It is undoubtedly advisable to cut out every tree showing canker on the stem, and to underplant with some shade-bearing tree to fill up the blanks. In pure larch woods this may mean the total sacrifice of the crop, but the moral of that is never to plant European larch pure.

Attempts have been made to detect and define causes contributory to the primary agent in the disease, such as elevation, aspect, soil, climate, successive crops of larch, etc., but the evidence obtained in respect to all these points has been exceedingly conflicting. One thing is certain, that the fungus *Dasycypha* is no new organism; it is a parasite upon larches in their native woods; it has been found in Scotland growing upon Scots and Corsican pines. It is impossible to prevent trees being wounded so as to admit the parasite; the most careful handling and tending will not avert lesion or puncture by frost, wind, insects, and birds. The only effective precaution possible is to secure such conditions as are known to promote vigorous, normal growth in larches, and to plant them in company with other trees, especially beech. No commoner cause exists predisposing trees to disease than nursery mismanagement. If seedlings and transplants are not placed in trenches sufficiently deep to allow the roots to lie straight, if they are planted too deep, or if, when planted out finally, either of these errors are committed, the vitality of the plant, especially if it is a conifer, is seriously lowered, for during several seasons it has to waste the energy which ought to be applied to growth in repairing the mischief arising from improper handling. Remedy for the larch disease, once it has gained a footing, there is none; preventive measures are embraced in good cultivation, remembering that in Britain we are dealing with an alpine tree in a lowland environment; and that unless the larch can be reconciled to that, canker must prevail against it.

Larch seed should be obtained from trustworthy continental firms, as it is almost impossible to ensure the quality of British seed which may have been saved from trees whereof the vitality has been impaired by disease. Planters should grow their own larch from seed, whereby the plants are obtained at a much cheaper rate than from nurserymen, and all risk of root-drying in transport is avoided. One pound of well-ripened larch seed, cos about 3s., contains about 70,000 grains, and ought to produce about 50,000 seedlings. Transplanted into nursery rows at one year old, 4 inches apart and 6 inches between the rows, they may be planted out on ploughed or bare ground at two years old, or on rough ground at three to four years old.

THE SIBERIAN LARCH (*Larix siberica*, Ledebour, *L. Ledebourii*, Gordon) is a native of the Altai Mountains in Siberia, and of parts of Northern Russia, and closely resembles the common larch, but the cones are smaller and the growth more erect in isolated specimens. Its timber is similar to that of European larch, but the tree is not so well adapted for the British climate, which does not afford it a complete winter rest and starts it in growth too early in spring.

THE JAPANESE LARCH (*Larix leptolepis*)—*Leaves* rather more than ½ inch long, bluish-green. *Bark* of young shoots clear ruddy brown, not ashen-yellow as in the common larch. *Cones*, ¾ to 1¼ inch long, ruddy brown. *Bracts*, soft, slightly bent back along the edge, about twice as long as the scales (shortened from Nisbet).

This larch, which was first brought to Europe in 1861, bears a general resemblance to the European larch, but is of more rapid growth and branching habit. The most conspicuous superficial difference consists in the beautiful reddish tinge of the young wood as compared with the pale yellow of the European species. Mr. Kumé, Chief of the Imperial Bureau of Forestry, Tokio, describes the timber as strong and resinous, somewhat hard and durable. It appears to be suitable for every purpose to which common larch is applied. Its behaviour as a young tree in Britain seems to indicate a very valuable addition to our woodlands; the exceeding vigour of its growth, at all events in its early years, bids fair to resist the larch canker, and its luxuriant foliage has not yet suffered from aphis or caterpillar. In Japan it grows best at an elevation of 3000 to 6000 feet, and, unlike the European larch, is found in pure forest. The State forests of this tree near Mount Asama extend to 24,507 acres. Mr. Kumé gives the following information as to propagation:—

"The seed, which ripens in autumn, is usually obtained from trees sixty to a hundred years old, the quantity sown being 0·8 lb. per square yard. The growth of seedlings is about 4 inches in the first year; but by the end of the second year they reach about 1·7 inches in height, and are sometimes then planted out into the woods. The first year's seedlings should be kept in moderate shade during summer, and in the spring of the second year they should be transplanted."

The Japanese larch requires different treatment from the European species, owing to its greater tendency to throw out side branches. Like that species, it is an imperious light-demander, and its robust growth enables it to outstrip and suppress almost any tree that could be planted with it. Probably it will prove best to plant it pure, as it naturally grows unmixed; though it might succeed if planted with Sitka spruce (*Picea sitkensis*). Such a mixture, however, might encourage an outbreak of aphides, the spruce and larch aphides being interchangeable forms of the same species. On the whole, until longer experience has been obtained of its behaviour in Western Europe, it seems advisable to plant the Japanese larch pure at

4 feet × 4. It prefers, if it does not require, a somewhat rich soil for its proper development, the finest growths in Japan being on volcanic dust. Good seed can now be obtained at a very cheap rate.

THE KURILE LARCH (*Larix curilensis*, Mayr).—A native of the Kurile Islands in N.-E. Japan, at an elevation of 1500 to 2500 feet, was brought to Europe in 1889, and has proved quite hardy in Britain. Its growth when young is said to be even more rapid than that of *L. leptolepis*, and it has been recommended for trial on hot, dry soils. It is easily distinguished from the other larches by the bark of the shoots, which is deep reddish-purple.

Of the three American species of larch, commonly known as Tamarack, only *Larix occidentalis* is worth attention from British foresters, who, as yet, have had no opportunity of testing its quality, owing to the difficulty of obtaining seed. It is the loftiest of all the genus, growing scattered or in small groups at elevations of 2000 to 7000 feet in Southern British Columbia, Montana, Oregon, and Idaho, reaching a height of 250 feet in moist bottom lands, and of 100 feet on dry mountain sides. The narrow, pyramidal heads of mature trees are very small in proportion to the tall bare trunk, and seed can scarcely be obtained except by felling the parent. The timber is said to be equal in excellence and durability to that of European larch, but Professor Sargent has a discouraging note about this tree, which, he says, when planted in the Eastern States and in Europe, "shows little promise of attaining a large size or becoming a valuable ornamental or timber tree." Dr. Henry visited the forests where this larch grows in the autumn of 1906, intending to obtain seed, but there was no crop.

(6) *Pseudo-larix*, the Golden or Chinese Larch (formerly *Larix*).—This genus contains but one species, *Pseudo-larix Kœmpferi*, distinguished from the true larches by the cones, of which the scales are not persistent, but fall asunder on the slightest pressure when ripe. It is a native of Northern, Eastern, and Central China, where it is found 120 to 130 feet high. It is quite hardy in this country, and well deserves a place in choice collections on account of its beautiful foliage, which turns bright yellow in the fall. The leaves are $1\frac{1}{2}$ to $2\frac{1}{2}$ inches long, and the general habit of the tree similar to that of the European larch.

THE CEDAR.—The genus *Cedrus*, belonging to the cone-bearing family (*Coniferœ*), is usually considered to consist of three species, namely, the cedar of Lebanon (*C. Libani*), the Deodar (*C. deodara*), and the Mount Atlas cedar (*C. atlantica*), but there is no specific difference between them, and they are probably no more than climatic varieties of a single species. In appearance and habit, however, they are very distinct, especially in a young state. They are lofty evergreen trees, with linear leaves, scattered or in alternate tufts. Flower monœcious, the male catkins solitary, cylindrical and terminal, the female oval and blunt, solitary, or rarely two together, erect on the branches. Stamens in catkins; anther-lobes 2, crested; pollen cells winged. Cones ovoid, blunt at the apex, smooth, erect, with smooth scales overlapping, more or less deciduous, each scale covering two seeds with large, membranous, truncate wings. Cotyledons leafy, eight or nine, entire, three-sided, much longer than the adult leaves.

The three kinds of cedar are perfectly hardy in all parts of the United Kingdom, but their quality as a timber-producing tree has never been properly tested, as they have not been subjected to forest conditions, but planted purely for ornament. That purpose they well fulfil; the Lebanon variety attaining majestic proportions, being usually far-spreading in habit,

with a tabular outline, owing to being planted as isolated specimens in parks and pleasure grounds. It is a tree of peculiar interest, for the forests of Lebanon receive frequent mention in Holy Writ; and, if Sir Joseph Hooker's calculation be correct, some of the cedars still growing there may have sprung from seed borne upon trees which fell under the axes of King Solomon's "fourscore thousand hewers." Of the forest which this incredible

Incense Cedar.

army of woodmen attacked, Sir Joseph Hooker found nine groups of cedars remaining in 1860, numbering about 400 trees in all, which he considered to vary in age from 100 to 2500 years. The height of 90 feet, attained in 1891 by a cedar of Lebanon at Methven in Perthshire, does not seem to have been exceeded in this country, although the tree was introduced early in the seventeenth century; but there is no reason to doubt that, under forest treatment, it would attain a stature going some way to justify the prophet

Red Cedar.

Ezekiel s description as "exalted above all the trees of the field" (Ezek. xxxi. 5).

The Atlantic cedar is more rapid in growth, and naturally of a more upright, less spreading habit than the cedar of Lebanon. Its leaves are shorter than those of that variety, arranged in tufts, but occurring singly on the younger shoots. It is a native of the mountain ranges of Algeria at an elevation of 7000 to 8000 feet. There is a beautiful variety

known as *C. atlantica glauca*, the foliage of which is of a fine bluish tint, suggesting frosted silver. It has to be propagated by grafts or cuttings.

The third variety of cedar, the deodar, was first brought to England in 1822 from the Himalayas, where it grows in vast forests at an elevation of 6000 to 12,000 feet, and attains a height of 200 feet. The Hindu name, Devadaru, means "the divine tree," and the timber grown at the higher levels and on northern slopes is much valued on account of its durability and fitness both for boat-building and architecture. But deodar timber grown at lower levels on southern exposure and richer soil is of very inferior quality, nor is it probable that any of the three cedars could ever be grown for profit in the United Kingdom, though exceedingly ornamental in sheltered positions. In a young state, the drooping young shoots of the deodar render it a more graceful tree than the other two cedars.

There are many varieties of all three cedars, the most notable being *C. atlantica glauca*, whereof the foliage is of a delightful glaucous tint.

The cedars prefer a somewhat dry soil with a permeable subsoil. In other respects they are not fastidious as to soil. They flower in autumn, and the cones remain two years on the tree before the seed ripens, when it should be gathered and stored till April, to be sown 2 or 3 inches apart in rows. The seedlings appear in about a month, and grow as much as 8 to 12 inches high before the autumn. At this stage, and for two years later when transplanted in the nursery, they are very sensitive of frost, and require the protection of branches set in the rows; but after that they pass uninjured through our hardest winters.

Fish Manures.—Like other animals, fishes contain the ingredients which are employed in building up the structure of plants. The softer tissues resemble flesh in composition, while the bones contain potash in abundance as well as phosphates. Under the term fish manures are included fish guano, a material which was first manufactured in Norway, but is now made extensively in the United Kingdom. As is well known, guano is derived from the dung of fish-consuming sea fowl, and this fact indicates that a manure made directly from fish must have points in common with guano. One objection to fish as a manure is the large amount of oil they contain, which in the case of guano is eliminated in the processes of digestion. Fish manures are therefore slower in acting than guanos, and require to be exposed to the fermentative action of the soil for some time before they are available for plant food. Oil contains no nitrogen, and belongs to the hydrocarbons. It does not possess any fertilising properties, and is detrimental on account of its retarding complete decomposition. Fish is, however, a valuable fertiliser, and has long been known in connection with hop cultivation. The supply is exhaustless, and it has been pointed out that no better method of recovering the waste fertilising matter which finds its way to the ocean can be devised than the employment of fish manure. The chief source of fish guano is fishery refuse, but fish themselves when caught in enormous quantities are employed or may be used intact as manure. Thus sprats are largely used in Essex, Kent, and Sussex, upon hop grounds and for corn, as well as for other crops. The refuse of pilchards, cod, ling, dog-fish, and whale-blubber are all esteemed, as are also mussels, star-fish, and molluscs of all kinds. We cannot refrain from mentioning seaweed or seaware in this connection as helping to show the enormous and everlasting supply of manurial matter which may be rescued from the sea and converted into fertilising matter.

There is a great similarity in the composition of fish of various sorts, as well as a close approximation to that of flesh. In the fresh state fish contain 63 or 64 per cent. of water and 36 to 37 per cent. of organic matter rich in nitrogen. Sprats contain 15 to 18 per cent. of dry nitrogenous matter containing from 11 to 12 per cent. of nitrogen. The ashes of fish have been found to contain 40 to 43 per cent. of phosphoric acid, which is equal to that contained in the richest phosphatic guano. Analyses of the ash of sprats were found to contain—

Phosphoric acid	42·4	per cent.
Lime	25·45	"
Magnesia	3·22	"
Potash	19·56	"
Chloride of sodium	6·25	"
Peroxide of iron, soda, etc. . .	3·12	"
	100·00	"

We therefore find in fish an abundant source of nitrogen, phosphoric acid, potash, and lime, or of all the principal fertilising ingredients. A dressing of 100 bushels per acre of sprats is often applied to hops, and about 30 bushels per acre to grain crops. Herrings are equally useful when they are caught in superabundant quantity.

The so-called fish guano manufactured in this country as well as in Norway is of variable quality, according to the processes employed and whether made from whole fish or fish offal. The offal contains a large proportion of heads and bones, and is therefore richer in phosphates and potash salts; while that made from whole fish is richer in nitrogen. The best quality of fish guano contains about 10 per cent. of nitrogen, but in ordinary cases it is nearer 8 per cent.

It is needless to quote cases in which the use of fish guano or of fresh fish has produced marked effect on crops. The composition is a sufficient guarantee of the value of such applications.

Fixtures.—There is a maxim of English law which lays down that whatever is attached to the freehold becomes part of the freehold, and belongs to the owner of the freehold. In this article it is proposed to confine the discussion of the principle and its application for agricultural fixtures. The question of the removability of agricultural fixtures only arises as between landlord and tenant. As between heir and executor, or legal personal representative of a tenant for life and the remainder man, such fixtures are never removable.

It is impossible to define with accuracy the word fixture; whether a chattel has been so attached to the land as to become a fixture or not, is a question of fact in each case, depending chiefly on the lasting nature of the attachment and the intention with which it was attached. In some cases, as will be shown later, actual attachment is not necessary. One of the best general guides on the subject is to be found in the judgment of Blackburn, J., in *Holland* v. *Hodgson*, 1872, L. R. F. C. P. 328, where he states that articles not otherwise attached to the land than by their own weight are not to be considered as part of the land, unless the circumstances are such as to show that they were intended to be part of the land, the burden of showing that they were so intended lying on those who

assert that they have ceased to be chattels; and that, on the contrary, an article which is fixed to the land even slightly is to be considered as part of the land, unless the circumstances are such as to show that it was intended all along to continue a chattel, the burden of proof in this case lying on those who continued it as a chattel.

The following cases will assist to form a conclusion as to whether an article has been so affixed to the freehold as to become part of it or not:—

Instances of articles held not to be fixtures.—A barn built on battens and blocks of timber lying on the ground but not fixed in or to the ground (*Culling* v. *Tuffnell*, 1694, Bull N. P. 34). A barn resting by its own weight on stavels (*i.e.* blocks of stone) which were fixed into the ground or let into brickwork (*Wansbrough* v. *Maton*, 1836, 4 Ad. & El. 884; *Wiltshear* v. *Cottrell*, 1853, 1 E. & B. 674). A wooden windmill resting by its own weight on a brick foundation (*R.* v. *Otley*, 1830, 1 B. & Ad. 161).

Instances of articles held to be fixtures.—Stavels or staddles (*i.e.* blocks of stone let into the ground or into brickwork for the purpose of carrying barns or ricks) (*Wiltshear* v. *Cottrell*, 1853, 1 E. & B. 674); a threshing machine fixed by bolts to posts let into the ground (*ibid.*); a gas-engine used to drive a sawmill, bolted to a bed of concrete (*Hobson* v. *Gorringe*, [1897] 1 Ch. 182); brick pillars built on a dairy floor to hold milk pans (*Leach* v. *Thomas*, 1835, 7 C. & P. 327); a steam-engine, boiler, hay-cutter, and malt-mill firmly fixed to buildings, and grinding stones, the lower of which was boxed on to the floor, the upper stone being attached with running gear in the usual way (*Walmsly* v. *Milne*, 1859, 7 C. B. N. S. 115). In one case a tenant commenced to build a wooden shed on posts driven into the ground, with wood supplied partly by his landlord and partly by himself. Before the building was completed the landlord sold the property to another person and the tenant gave notice to quit to the new landlord. It was held, that the incomplete building was a fixture, and that the tenant had no right to remove it (*Smith* v. *Render*, 1857, 27 L. J. Ex. 83). In another case it was held, that when the tenant of a house removed the fixed grates therefrom and replaced them with dog grates which were not fixed to the building, but merely rested on the hearth, the new grates were fixtures (*Monti* v. *Barnes*, [1901] 16 B. 205). The reason of this decision was, that the new grates were installed in place of the old fixed grates with the view of improving the inheritance.

A fixture being the property of the owner of the freehold, it follows that the tenant cannot remove it. Trade fixtures can be removed by the tenant, but it was held as long ago as 1802 that this exception did not apply to agricultural fixtures (*Elwes* v. *Maw*, 1802, 3 East. 38). The right to remove agricultural fixtures depends on the following Acts of Parliament:—

The Landlord and Tenant Act, 1851 (14 & 15 Vict. c. 25), s. 3, enacts, that if a tenant of a farm or lands, after 24th July 1851, erects at his own cost and expense, and with the written consent of his landlord, any farm buildings, or puts up any other building, engine, or machinery, either for agricultural purposes or for the purposes of trade and agriculture, which he is not bound to put up in pursuance of some obligation, all such buildings, engines, and machinery shall be the property of the tenant and removable by him, notwithstanding that the same may consist of separate buildings, or may be built in or permanently fixed to the soil. The tenant in making the removal must not injure the landlord's land or buildings,

and must put the landlord's land and buildings in the same or as good plight and condition as they were before the erection of anything removed. The tenant must give the landlord one month's notice of his intention to remove; and the landlord may elect to purchase the things proposed to be removed or any of them, the value being ascertained by two referees, one chosen by each party or by an umpire named by the referees.

The above Act is not now often resorted to owing to the provision of the Agricultural Holdings Act, 1883 (46 & 47 Vict. c. 61), the effect of S. 34 of which is as follows:—Where a tenant after 1st January 1884 affixes to his holding any engine, machinery, fencing or other fixture, or erects any building for which he is not entitled to compensation under the Agricultural Holdings Acts (see that Title) or otherwise, and which he has not affixed or erected in pursuance of some obligation, or instead of some fixture or building belonging to the landlord, such fixture or building is the property of and is removable by the tenant before, or within a reasonable time after, the determination of the tenancy. Before the tenant removes any fixture or building he must pay all rent owing by him, and must perform or satisfy all his obligations to the landlord in respect of the holding. He must not do any avoidable damage to any other building or to any other part of the holding, and immediately after the removal he must make good any damage to other buildings or to other parts of the holding occasioned by the removal. He must also give the landlord one month's notice in writing of his intention to make the removal. At any time during the month the landlord may give the tenant written notice of his intention to purchase the fixture or building; and if he does so it becomes the property of the landlord, and the tenant must leave it. The landlord must pay the tenant the fair value to an incoming tenant. Any difference as to the value is to be settled by a reference under the Act as to compensation, but without appeal (see AGRICULTURAL HOLDINGS ACTS). Under the provision of this latter Act it is unnecessary to obtain the landlord's consent for the erection. The Agricultural Holdings Act of 1900 (63 & 64 Vict. c. 50, s. 4), extends the above provisions to fixtures and buildings acquired by the tenant as if they had been erected by him.

Market gardens by S. 3, ss. 1, of the Market Gardeners' Compensation Act, 1895. The above provisions apply to every fixture or building affixed or erected by a tenant for the purposes of his trade or business as a market gardener, to be let or treated as a market garden under an agreement in writing. Sub-section 5 of the same section gives the tenant power to remove all fruit trees and fruit bushes planted by him and not permanently set out. They must, however, be removed before the end of the tenancy, or they become the property of the landlord without liability to pay any compensation.

Time for removal.—Apart from the statutory provision set out above, the time during which a tenant may remove fixtures is not very clear. The clearest statement of the law is contained in Baron Alderson's judgment in *Weston* v. *Woodcock* (1840, 7 Mu. & W. 14):—"The rule to be collected from the cases on this subject seems to be this, that the tenant's right to remove fixtures continues during his original term, and during such further period of possession by him as he holds the premises under a right still to consider himself a tenant." It will have been noticed that the Agricultural Holdings Act, 1883, allows the tenant to remove fixtures within a reasonable time after the termination of the tenancy. The question as to what is a reasonable time has never been

decided, but it should be noticed that the fixtures are made the property of the tenant, who would have a right of action against the landlord for refusing to allow him to remove them. Unlike the provisions of the Acts as to compensation, the tenant may agree with the landlord that he is not to have the benefits of S. 34 set out above.

Flax (German *Flachs*) belongs to the botanical genus *Linum*. The culture and manufacture of flax must have been well known to the people of ancient Egypt, for it is recorded in Genesis that Pharaoh arrayed Joseph "in vestures of fine linen." Among Western nations flax had no rival as a vegetable fibre until the rapid rise of the importations of cotton at the end of the eighteenth century. Up till that time and even considerably later, large quantities of flax were grown in this country—in fact, one of the best known Scottish banks, namely, the British Linen Company, was originally a linen manufacturing concern. Since then, however, economic and other causes have reduced the cultivation of flax in Great Britain almost to the vanishing point, the Agricultural Returns for 1907 indicating that there were then 372 acres under this crop in Great Britain. Under the fostering care of the Irish Department of Agriculture—which is most commendably desirous of maintaining and encouraging all the rural industries of Ireland—some 59,000 acres are grown in that country. But the growing of flax for fibre involves a great amount of labour, some of which is not of the most agreeable character, and the returns from the crop are not of a kind that are calculated to lead to an extension of flax-growing wherever high-priced land and high-priced labour have to be reckoned with.

The flax crop can be grown on any loamy soil, but it is not suited for either light gravelly or heavy clay soils. It cannot, however, be grown on the same soils except after an interval of seven to nine years. Numerous attempts have been made to shorten the rotation, but these have invariably ended in failure. It is usually grown after a crop of potatoes, or a crop of oats following lea. If the crop be grown for fibre, the soil must not be heavily forced with manure. The Irish Department of Agriculture have conducted numerous experiments in regard to this point, and in the beginning of 1908 they published a pamphlet on flax-growing in which they give the results of five years' experiments, which lead them up to the conclusion that the only artificial manure that can be profitably applied to flax grown for fibre is potash in any of its forms—kainit, muriate of potash, or sulphate of potash. They say: "The Department would therefore again advise growers to use a potassic manure for flax, and also to give preference to muriate of potash. To facilitate the even distribution of a small quantity of this manure (1 to $1\frac{1}{4}$ cwt. per statute acre) it may be mixed with sand or fine soil, and its bulk so increased." On the other hand, when flax is grown mainly for seed with less regard to quality of fibre, the crop may be forced more or less by manures both natural and artificial. The amount of seed required per acre ranges from 6 to 12 pecks per acre, the larger quantity being used when the crop is grown for fibre. The seed should be drilled in and lightly covered. Seed grown in Holland—which in turn is largely grown from Riga seed—has been found to give the best results in Ireland. The seed is sown in April, and the crop grows to a height of 25 to 40 inches. It blooms in June to July, and if intended for fibre it should be pulled shortly after blooming. If grown mainly for seed, the crop must be allowed to mature, as the seeds are about as valuable as the fibre. If grown for fibre, as it

mainly is in Ireland, it should be pulled shortly after the blooming season, then rippled, *i.e.* drawn in handfuls through the teeth of an iron frame to separate the immature seed, then retted (or rotted) in soft water, after which it is bleached by being spread evenly over a grass field, where it is allowed to lie for a few days, and is frequently turned during the process of bleaching. After this it is ready to be "scutched"—the scutching being a mechanical process which removes the rotten woody and mucilaginous matter from the fibres. The Irish Department in their pamphlet published in 1908 quote the results of an experimental plot as follows:—

Average yield of retted straw	2855 lb.
Average yield of scutched flax	30 st. 8 lb.
Percentage of scutched flax from retted straw	14·99
Average value of scutched flax per stone	7s. 10¼d.
Average return from scutched flax per statute acre	£12, 0s. 5d.
Average return from tow per statute acre	£1, 1s. 9d.
Average return from scutched flax and tow per statute acre	£13, 2s. 2d.

In view of the large amount of labour involved in the handling of the crop—not to speak of the cost of growing—this very modest return is amply sufficient to explain why flax-growing has not been popular in recent times with the farmers of Great Britain. When flax is grown mainly for its seed—linseed—the crop must be well matured, and may be cut by the mechanical reaper instead of being pulled. A full crop will yield from 15 to 20 bushels of linseed per acre, but the fibre in that case is of much less value, though there is always a demand for the straw for paper-making. The linseed is for the most part crushed by way of expressing the oil, the residue forming linseed cake (*see* Linseed). For economic and other reasons flax-growing for fibre, or for seed, has now been largely relegated to those countries where cheap land and cheap labour are to be had. Northern Russia is said to grow half the flax grown in the world. In Argentina, where the crop is grown mainly for the seed, an enormous area is devoted to flax culture, the annual output of linseed being about a million tons. Our annual imports of flax for manufacturing purposes average 75,000 tons, of the value of 3¼ millions sterling, and our annual imports of tow, *i.e.* broken fibres removed in scutching, average 15,000 tons, representing an annual value of £350,000. In the same way our annual imports of flax seed, *i.e.* linseed, average 2 million quarters, representing a value of over 3½ million pounds sterling (*see* Linseed).

Flock Books.—Every established breed of sheep is now represented by a Breed Society, and most of these publish a flock book. The object is registration of flocks and of sires, by name and number, and in some cases females are individually registered as well as rams. The flock about to be registered is visited by a deputation from the Society, and, if approved, it is recommended for registration. It is evident that if a flock is worthy of admittance on account of its history and character, and a continuous record is afterwards kept of all sires used, it speedily becomes a recognised pure-bred flock. The large number of ewes maintained in the case of some breeds, as, for example, Hampshire Downs, renders it difficult to preserve pedigrees of individual females, so that generally the record of the flock is a register of sires used from year to year.

The following entry in the Hampshire Down Flock Book indicates the system usually followed:—

NAME AND ADDRESS OF BREEDER.

Flock entered in vol. i. page 13.

Present flock on the 1st of December 190—.

1005 Breeding ewes,
320 Ewe tegs,
23 Rams.

Replenished during the year by the purchase of

(Here follows a list of replenishments with names.)

RAMS IN SERVICE DURING THE YEAR.

1 Shearling, Fortification (4873).
1 do. Financial Friend (4865).
1 Lamb from Lord R., Royal Warrant (5558).
Etc. etc.

The entry closes with a list of prizes taken by the flock during the previous year.

The first part of the volume is occupied by records of the various flocks as above; and the second part is devoted to the registration of rams and ram lambs, each having a flock book number attached. It is therefore easy to construct a pedigree of any ram by referring to his entry in the flock book, which gives his sire's name and number, as well as his own, and this quest can be continued back to vol. i. if the pedigree extends back so far. The value of the female pedigree rests on the flock and its reputation. In the case of some favourite families, or in that of small and choice flocks, the ewes' pedigrees are kept; but in the case of large flocks this would entail a vast amount of trouble. Flock books also contain the Articles of Association and Rules and Regulations, and are duly edited and kept up by a permanent Editor and Secretary. It would be superfluous to give particulars here as to the addresses of the various sheep societies; but the Secretary of the National Sheep Breeders Association, Mowbray House, Norfolk Street, Strand, London, W.C., would put an inquirer into communication with any of them. The almanacs published in connection with most of the leading agricultural newspapers contain the addresses of all descriptions of agricultural societies, among which the Breed Societies occupy an important position.

Flower Farming.—INTRODUCTORY.—In reference to cut flowers at least, flower growing for market may be described as quite a modern industry. At any rate, it was quite insignificant fifty years ago, whereas, at the present time, it is an enterprise of vast importance. Pointing to a glass-house of moderate dimensions, which he had erected as a show-room for his wholesale customers to visit, a grower of flowers near London, who is but little over middle age, declared that he could remember the time when the whole supply of Covent Garden Market could have been placed in it; but now an immense covered market is filled with flowers and foliage plants grown in England, while another great building is devoted to flowers from the Scilly and Channel Islands and foreign countries. Thousands of people of modest means, whose forefathers in a like position

would have regarded it as a gross extravagance to spend money in flowers, except for a few in pots, now buy cut flowers regularly. To a great extent it may be said that the supply has created the demand, as the choice varieties of beautiful flowers now displayed in shops and hawked about the streets of all large towns are so moderate in price that they present a strong temptation to the public.

There are no statistics of the acreage devoted to flowers for market, and it would be impossible to obtain them accurately, as it has become the practice of cottagers who live alongside the main roads of the country to grow them in their gardens for sale to passers-by, and some of these people make welcome additions to their small incomes in this way.

Flower Farming in the Open.—In the old market gardens around London, flowers to a great extent have encroached upon the space formerly devoted to culinary vegetables or fruit. First vegetables were driven further afield to give place to fruit and flowers, and later on bush fruits, grown between trees, were partially displaced to make room for flowers. There are also farms of moderate size around the Metropolis and other large towns, as well as some in remote districts, devoted entirely or partly to flowers for market.

Perhaps the most remarkable branch of the flower-growing industry, in relation to modern development, is that of the numerous varieties of the narcissus. Some living men can remember the time when the double yellow daffodil and about half a dozen other flowers were the only varieties of the narcissus commonly grown in ordinary gardens, whereas at present there are over six hundred varieties, although comparatively few of them are grown on a large scale. It was not until about 1840 that the late Dean Herbert, one of the first Englishmen to raise hybrid narcissi, if not the first of all, began his work, and it was twenty years later before most of the varieties now most extensively grown were brought out. About fifty years ago small quantities of two of the oldest varieties were grown by one man for market in the Spalding district; but it was not until many new and attractive varieties became known, fully ten years later, that the demand began to justify production upon a considerable scale. Mr. Barr, of Long Ditton, near London, who has been one of the most noted pioneers in hybridising narcissi, and placing new varieties on the market, began operations in the seventies, and it was during that decade that the bulbous flower enterprise was started in the Scilly Isles, which long stood pre-eminent as sources of the market supply, and probably are so still, although Lincolnshire and a few other counties are now great producers.

It was not until 1870, or a year earlier, that the first box of narcissi was despatched from the Scilly Isles to the London market. The flowers sold so well that the islanders began to collect the wild ones growing in their fields for sale, and to transplant the bulbs to cultivated ground. There were only nine varieties at that time in the islands, while now fully thirty are extensively grown, and others on a comparatively small scale. In 1870 potatoes were the chief products of the islands, apart from corn, a moderate quantity of asparagus being also grown. But the success of the trade in narcissi and other flowers soon drove corn nearly out of cultivation, and restricted the production of potatoes within narrow limits. By 1896 no less than 514 tons of flowers were shipped from the Scilly Isles. A few years later the area devoted to flowers was over 500 acres, all but a small proportion being covered with narcissi. A few forced flowers are ready at Christmas; but there is very little glass in the islands, nearly all the flowers being grown in the open. The industry is favoured by a mild and equable climate.

The commercial bulbous flower industry in Lincolnshire began to assume considerable proportions a little over twenty years ago. One grower in the Spalding district, who was a pioneer in this connection, had 24 acres under flowers, all narcissi except a few lilies, crown imperials, irises, and gladioli twelve years later. He was then the only extensive grower in the district; but there were many small growers. Near Boston and in other parts of Lincolnshire also there are many growers of flowers, including lilies of the valley, spireas, and aconites.

In Cambridgeshire, and particularly in the neighbourhood of Wisbech, bulbous and other flowers are grown on a large scale, one producer having over 50 acres devoted to them.

For flowers of various descriptions grown in the open, the Thames Valley and other districts near London, in Middlesex and Surrey, are pre-eminent so far as the market industry is concerned. One firm at Mitcham had 80 acres devoted to flowers some years ago, and probably has more now. This is possibly the largest flower farm in the United Kingdom. There are also some extensive growers at Woking, about 25 miles from London; and near Swanley in Kent one firm has about 100 acres under flowers, shrubs, and fruit and foliage trees. Roses are grown largely to the north of London, and to a considerable extent in the Thames Valley. Colchester is a famous place for roses, but more for the sale of plants than for that of cut flowers. Flower farming in the open for market is also pursued in almost all parts of England to some extent, and it is an industry of some importance in Guernsey. The production of bedding plants is one of the most important branches of the enterprise, and this is carried on largely in parts of the north of England and Scotland.

Flower Growing under Glass.—The production of hothouse flowers has reached very large dimensions. In most of the extensive glass-house nurseries, referred to in the article on "Fruit Growing" flowers are largely grown, the London districts being more noticeable than Worthing in this connection, though almost all nurserymen grow chrysanthemums largely, if they do not go in for miscellaneous flowers. Not a few of the large nurseries are devoted entirely to flowers, and enormous numbers of ferns and other pot plants are raised in many of them. One grower near London disposes annually of about 200,000 ferns, 80,000 pelargoniums (commonly called geraniums), 60,000 palms, 20,000 marguerites, 20,000 pots of mignonette, and smaller quantities of numerous other pot flowers; while one Cheshunt grower produces fully a million palms, an equal number of ferns, probably twice as many lilies of the valley, about 500,000 hyacinths, and a million tulips, with a vast number of orchids and other forced flowers. A Middlesex grower forces about 1,800,000 crowns of lilies of the valley in a season. These figures are given as examples of the enormous extent to which flowers are grown for market under glass, and many more examples might be cited. The industry is carried on to a great or small extent in almost all parts of Great Britain and in the Channel Islands, and particularly in the neighbourhood of large towns.

Fluke Disease.—*See* Liver Rot.

Foaling and the Treatment of the Brood Mare and Foal.—In considering this important subject it must be borne in mind that under natural circumstances there exist conditions favourable

to conception, giving birth, and the development of the progeny. Natural conditions should therefore be aimed at, though the artificial state, which domestication has entailed, must not be disregarded. Horse-breeding, as now necessarily carried on in Great Britain, cannot proceed exactly as in nature, but observation over an extensive field forces on us the opinion that breeding operations are more satisfactory as conditions approximating the natural obtain and where man's interference does least to disarrange or disturb them. Speaking generally, improper treatment of the mare and the foal is in the direction of misapplied care rather than of neglect. In many respects the greater attention paid to breeding animals has provided more favourable conditions; but while some of the obstacles to successful breeding have been removed, it would appear that in certain directions others have been substituted. These latter appear to affect the breeding of high-class, pure-bred animals, rather than common stock.

Among other circumstances which increase the risks of breeding is the now common practice of sending mares to the stud. The association of mares congregated from a great many sources immensely increases the risk from contagious disease. The germs of contagious abortion, joint-ill, strangles, or influenza are not infrequently carried to their homes by mares and foals returning from the stud. The primary condition is the fitness of the brood mare from all points of view, including that of freedom from hereditary defects, but for the purposes of this article the consideration of her treatment commences with the termination of her previous pregnancy, or with the first service of the barren or maiden mare. The oncoming of œstrum or "season" is usually in the spring or early summer. It generally lasts from two to four days, and, varying considerably with the nature and quantity of the food, the individual temperament of the mare, etc., returns every two to four weeks during spring and summer. If the previous foaling has been normal, the stallion may be offered for service after an interval of from eight to twelve days, the ninth being regarded by many as most desirable. If, however, there be reason for thinking the previous birth premature, that abortion had taken place, that the womb had been injured or parts of the foal bed retained, it will be well to delay service for some six or eight weeks. In this interval the womb should be washed out three or four times, and the treatment of the hinder parts, etc., the same as that advocated when abortion is known to have occurred.

From reports which have reached us we are disposed to the opinion that the number of mares which fail to conceive or carry to full time is increasing; it has been computed that not more than 60 per cent. of mares served produce living foals. Doubtless some proportion of this failure is dependent on accidents, others on anatomical and other peculiarities over which we have no control, while in other cases the obstacle is overcome by artificial insemination. It is, however, highly probable that contagious abortion is responsible for much of this trouble. With a view to lessening the chances of communicating contagious disease, possibly acquired in transit or at the place visited, it is advisable to isolate the mare and the foal for two or three weeks after their return from stud. It appears necessary to demand some evidence of freedom of a stud from contagious disease before sending mares; and it may not be forgotten that the travelling stallion may prove a medium for conveying disease without showing evidence of its existence in himself.

It is usual to assume that conception has taken place if there is no

return of "season" within a fortnight or three weeks of service. Unfortunately, this assumption is not invariably correct, while it is by no means an unknown circumstance for "season" to occur after conception has taken place.

During pregnancy moderate exercise is essential. Work, which is free from special risk of accident, is quite compatible with the well-doing of the mare and fœtus. This should always be gentle. It is often carried on up to within a few hours of foaling without apparent ill effects. It is, however, regarded best not to work the pregnant mare after completion of the tenth month, but it is most essential that after cessation of work she should have the fullest opportunity for gentle exercise.

Food and water should be good and of fair amount, remembering that in the latter months of pregnancy the fœtus has to be sustained. It is, of course, most important that food should contain all the elements essential to the development of the fœtus, but it may be taken that what is good for maintaining the health of the mare is proper for the fœtus, and conversely what is unfit for the fœtus is unfit for the mare, so that the only rule which need be observed is to supply a moderate quantity of sound food and water. Large meals of food or draughts of water should be avoided, and an in-foal mare should not be kept long from eating and drinking. Frozen food and very cold water and mouldy food are usually regarded as particularly dangerous. The last named is under any circumstances unfit feeding for horses, and a mare kept for a long time without food or water in gaining access to these at a low temperature may take either in such large quantities as to do harm, though we must record the fact that no small degree of success has been attained with mares largely subsisting on partly frozen grass and water. Overheating, especially if followed by large draughts of water, which often give rise to very active movements of the fœtus in the womb, may deleteriously affect pregnancy. Indeed, all sudden changes should as far as possible be avoided.

Shelter from rain, heat, and cold is best provided in open sheds with capacious entrances to which mares may resort at will. Undulating is preferable to flat or very hilly ground. Wet land is less suitable, and favours parasitic disease.

The pregnant mare is disposed to quiet, and should be preserved from frights, troublesome companions, etc. Indeed, preservation of the health of the mare, which means preservation of that of her offspring, must be on lines ordinarily applicable to horses.

Any tendency to constipation just before foaling may be corrected by a laxative diet, linseed or linseed oil mixed with food, but throughout, violent purgatives should as far as possible be avoided.

Approaching parturition is indicated by enlargement of the udder, swelling of which may extend along under the abdomen, sinking of the croup and quarters, sometimes swelling of the vulva, accumulation of wax at the openings of the teats, usually noticeable about from twelve to twenty-four hours prior to the appearance of the water-bag, which is soon followed by labour pains. The period of pregnancy having advanced to the time when foaling is to be prepared for, cleanliness of the surroundings is of the utmost importance. The greatest danger is probably connected with the foaling-box and the interfering attendant; the former may contain germs of contagious disease, and the latter may carry them from one mare to another or to the foals. Foals are not uncommonly born on manure heaps, and yet do well, but as we have no means of distinguishing dangerous from harmless dirt, thorough cleansing is our only security. The ideal life for the pregnant

and foaling mare is in the open, and many successful breeders of high-priced horses never house their brood mares, even for foaling. This is, however, not the generally adopted practice. In inclement weather or when manual interference is absolutely necessary, indoors may be deemed best. The mare should preferably foal in her own large, airy, disinfected loose-box, which, though open, should be free from draughts. If circumstances do not permit of this, and the use of the common foaling-box is deemed necessary, the greatest attention should be paid to its cleansing and disinfection prior to the admission of each mare. The attendant's hands, clothes, etc., should receive similar attention. No such regard for cleanliness is usually observed, and generally all goes well. Fortunately, germs which seriously damage the foaling mare or her offspring do not exist in large numbers everywhere. Experience, however, teaches that when such are existent their effect is usually serious, and as we have no practical means of recognising their existence except by their effect on our stock, precautionary measures, such as suggested, should, we think, be generally adopted.

A clean fresh bed being provided, the mare should be left as quiet as possible; the attendant is better unobserved, though hard by ready to render any assistance which may possibly be required. Examination of the passages with the hands, at any rate up to such time as any difficulty is manifested, should be prohibited, as no useful purpose can be served, while dirt may possibly be introduced, endangering the mare and foal. It must be remembered that the function of the "water-bag" is to open and expand the mouth of the womb, and to some extent lubricate the passages, and so facilitate delivery. If this bag is broken too soon, delivery will be retarded. Opinions differ as to whether this water-bag should ever be ruptured by the attendant, but it may be taken that under ordinary circumstances this should not be done before it has appeared as a large swelling protruding beyond the external opening. Should the water-bag become ruptured, before it has reached a considerable size, it may be expedient, after the hand has been thoroughly cleansed, to examine, and if the passages are dry, to introduce some vaseline, or to inject a little tepid water and glycerine with a syringe.

Under ordinary circumstances the act of foaling is gone through in a short period, sometimes within ten minutes of the first labour pain, while it is not usual for a living foal to be brought forth unless delivery is accomplished within six hours of the oncoming of the first labour pain. As a rule, the pains follow each other at about five minutes' interval. Occasionally there is a false alarm, a pain is noticed, and passes off, some hours elapsing before there is another, the mare in the meantime being quite well.

When a mare is much debilitated, contractions may be feeble and labour protracted, and the evident exhaustion call for a stimulant such as a few ounces of whisky. If labour appears not to proceed well, the attendant, after all due precautions as to cleanliness, may make an examination. If the forelegs and muzzle are in the passage, assistance may be rendered by traction on the forelegs, pulling backwards and downwards towards the hocks of the dam with each labour pain or expulsive effort. The mare perhaps more commonly foals in the standing position, and in the drop of the foal to the ground the membranes burst and the navel cord ruptures, thus rendering the foal free. When foaling takes place in the lying position, the rising of the mare usually severs the cord. Under all circumstances it is important that the foal should be free from the membranes as early as possible, and it may be necessary for the attendant to rupture them. When the mare remains lying down the navel cord sometimes remains unbroken. Under

such conditions the cord should be tied with a piece of disinfected twine or strong silk about from $1\frac{1}{2}$ to 2 inches from the foal's navel and severed on the mare's side by scraping with a clean disinfected knife, afterwards applying some disinfectant to the navel.

Should the newly-born foal show signs of lifelessness or fainting, it should be flecked or slapped with a wet towel, its nostrils tickled with a feather, the body rubbed with dry straw, and artificial respiration performed. As a rule, the foal soon finds the teat, though sometimes it may be necessary to direct him to it. It is important that the foal should take the milk which is in the udder at birth, as this possesses laxative properties essential to clearing out the matters which have accumulated in the intestines while in the womb. It is, of course, necessary that the dam should yield a fair amount of milk, and if this is lacking a substitute must be supplied. Cow's milk, to which a little water and a little sugar are added, answers the purpose. The cow's milk should be exposed to a temperature of 185° Fahr. for five minutes, and allowed to cool before being given to the foal. Mare's milk is, however, best for foals, and an attempt should be made to increase the natural supply, by giving the mare oats, bran, etc.

In considering the treatment of the newly-born foal, it must be recognised that all come into the world with a wound at the navel. This is a possible port of entrance of germs into the system of the young animal. To avoid infection through this channel, many regard it advisable to tie the navel cord of all foals immediately after birth, having first thoroughly disinfected the parts involved. If the cord is tied, and no germs are included, such diseases as navel or joint-ill will probably be averted. It is not always possible to secure this immunity from germs, and occasionally navel-ill manifests itself in foals whose navels have been tied. The failure accentuates the necessity of doing everything possible to render the surroundings into which the foal is born thoroughly pure; indeed, unless thorough precautions as to disinfection are observed, the tying of the cord may prove the means of conveying disease germs to the part and retaining them there. It appears to be within the range of possibility that the germs of joint-ill, like those of strangles, etc., may enter by the mouth, etc., and for this reason it is advisable to cleanse the udder and teats, and to squeeze a little milk out of the teats prior to the foal sucking.

When the presentation of the foal is abnormal or delivery not proceeding well, or any difficulty imminent, the service of the expert should be enlisted without delay, as neither foal nor mare will survive a very protracted parturition. Any retention of the after-birth should also be attended to by the expert.

After birth of the foal the dam should remain with it at rest for at least a month. If it is deemed necessary at the end of the month to work the mare, the foal should be allowed to suck every three hours, for the foal is adapted for "small quantities and often." Extra diet should be allowed the mare while suckling. The foal may be deleteriously affected through the milk of its dam, and many of the minor ailments are to be corrected only by attention to the dam. Warmth is essential to all young animals, but if the weather is suitable both should be turned out very soon.

It must be borne in mind that some mares "savage" and kill their foals, and care taken to watch from this point of view. A considerable number of mares will "fly at" and bite and even kill their recent progeny, if the latter are not covered with a rug.

The weaning of the foal should not be attempted until it is ascertained that he is capable of maintaining himself, and at first his appetite should be coaxed with some favourite food, such as crushed oats. The age at which weaning should take place will much depend on circumstances, and no hard-and-fast rule can be laid down except the above. Generally from four to six months is most suitable. For mare and foal it is much better that the weaning should be gradual; the food of the dam being curtailed, and the intervals between suckling being prolonged, and incomplete withdrawal of milk helps to "dry off" the mare, and so throw the foal on to its own resources. At all times foals should be "done well." To stint their food is the greatest of unwisdom, while the addition of a little crushed oats, bran, etc., will ensure the inclusion in the diet of all the materials essential to full development. A plentiful supply of pure water is advantageous, and in cold, wet weather extra food is called for alike by dam and foal.

The disease to which foals are most liable, and which is probably in all cases acquired before, during, or very soon after birth is known as joint-ill. This affection is dealt with in a separate chapter. (*See* Joint, Ill.)

A condition occurring exclusively in the very early days of separate existence is the "open urachus" or navel, with dribbling of the urine. This calls for immediate attention of the veterinary surgeon, as tying is sometimes dangerous or ineffectual.

The mare is liable to "blood poisoning," which may be manifested in various ways, by the general symptoms of fever, high temperature, etc., "fever in the feet," inflammation of the lungs, peritoneum, etc., all rendering cleanliness desirable. Retention of the after-birth, wounds of the womb and passages are always somewhat serious from this point of view. Injurious germs seem to develop freely under such circumstances, and the operation of removal of portions of long retained membranes is fraught with some danger to the operator. Many veterinary surgeons have been thereby seriously affected with blood poisoning. Cerebral excitement of the mare, sometimes of an acute character, may follow a few hours or days after foaling, and is usually amenable to veterinary treatment.

Beyond ordinary attention to the laws of health usually affecting horses, and particularly a good supply of food, shelter from wet and extreme cold, sound pastures, and clean water, the young animal requires no special care until some of the penalties of domestication, such as castration, docking, etc., appear called for. These operations are referred to under their respective headings.

Foot-and-Mouth Disease.—Foot-and-mouth disease, technically known as "Eczema Epizootica," is a highly contagious fever, principally affecting cattle, sheep, and pigs. Deer and other ruminating animals are also liable to its attack. It is said to occur occasionally in horses and the human subject, but from a practical point of view its occurrence in the three species first named is of prime importance. Though at present non-existent in Great Britain, it is prevalent in the Continent and elsewhere. For several years this malady has not gained any foothold in the United Kingdom, though on different occasions it has made its appearance here. In former days, however, it commonly existed in these islands and caused great monetary loss and annoyance to stockowners and materially affected the national wealth. Thirty or forty years ago it was a standing menace to agriculture; in 1871 it affected 691,000 animals in Great Britain.

At the present time there are comparatively few who have had personal experience with the disease, and it scarcely comes into consideration among the possible sources of danger and loss of the stockkeeper. Many circumstances have happened to show that, exempt as we have been for some years, a return of the mischief is not beyond the region of possibility. The disease has appeared in our herds at different times during the past twenty years, and only the prompt and decisive action of the authorities has prevented its spread and averted the consequent losses. The establishment of foot-and-mouth disease in this country would, by actual losses of stock, closing of markets, and prevention of movement, cause immense inconvenience, while all exportation of sheep, cattle, and pigs would be stopped, as no country which is sufficiently enlightened to frame laws to prevent the introduction of contagious disease to its stock will admit animals coming from a country in which foot-and-mouth disease is known to exist.

This disease is extremely contagious, spreading from animal to animal and from place to place easily and rapidly. Its virus has not yet been demonstrated, but it is known to be contained in the discharges of the affected animal, and that it lives a considerable time outside it. The disease is communicated from the affected to healthy animals by their coming in contact with each other. The virus can be conveyed by persons who have been in contact with affected animals, or with their discharges. A shed or field in which an affected animal has been may retain the power of infecting animals for a considerable time. Indeed, the virus may be conveyed by any medium, and probably one of the later outbreaks in England was due to the contagion being brought from abroad in straw in which eggs were packed.

Though in some outbreaks much more virulent than in others, foot-and-mouth disease is usually not fatal to adult animals, which, as a rule, recover, but a large proportion of young animals may die. In all animals it causes a good deal of suffering, and there is a considerable loss of condition, which means loss of money. Occurring in a herd of dairy cattle it is serious, as the milk must not be sold for human consumption, and if used for calves or pigs will convey the disease to them. It is sometimes even more serious when occurring in a flock of ewes with lambs, for not only do the mothers lose flesh but a considerable proportion of the lambs succumb. The period of incubation is very short, symptoms often being shown forty to fifty hours after a susceptible animal is exposed to infection, that is after the healthy animal has been in contact with one suffering with the disease. The virus acts by setting up fever and producing eruptions in the mouth or feet or both, while in cows the teats are sometimes so affected. The symptoms are connected with these conditions. In cattle there is always a high temperature and general depression, usually there are eruptions in both mouth and feet, consequently there is much smacking of the lips and dribbling of thick tenacious saliva. The eruptions or vesicles occur on the inner surface of the lips or the upper surface of the tongue. These are usually white blisters such as are seen in the human skin after scalds or burns; they usually break, and a bright red surface is exposed. Sometimes the vesicle is on the tip of the tongue, and the membrane is thrown off like a glove from a finger. There is lameness, and the animals shake their feet as though they would get rid of something irritating them there. On closer examination of the foot, vesicles similar to those in the mouth may be seen between hair and hoof; these burst as in the mouth, and sometimes dirt gets in, sets up inflammation,

and the horny claw is thrown off. In cows the tip of the teat may be similarly affected with vesicles, and occasionally the inflammation extends up the channel of the teat, and the udder becomes implicated. The course is short, and in some cases is passed through in seven or ten days, after which the animal usually begins to put on flesh, and in four weeks it may not be possible to find any evidence of the disease having existed. Abortion sometimes occurs in pregnant animals.

In younger cattle, lambs, and sucking pigs the depression is usually greater, and sometimes there is evidence of inflammation of the fourth stomach. There are few conditions likely to be mistaken for foot-and-mouth disease, though when the affection was rife in Great Britain false alarm was not uncommon. If cattle walk through unslaked lime the skin between hair and hoof may be somewhat similarly affected, but absence of any affection of the mouth will be noticeable and enough of itself to distinguish it from foot-and-mouth disease. Sheep and lambs are liable to an eruption on the lips and the membrane of the mouth, but the freedom of the feet will settle the matter. Indeed, in a considerable proportion of cases of foot-and-mouth disease in sheep there are no lesions in the mouth.

Foot-and-mouth disease is scheduled under the Contagious Diseases (Animals) Act, and any one who has any grounds for suspecting its existence in any animal must at once give notice to the local authority, usually the police, after which the Board of Agriculture deal with the matter. Their action will depend on circumstances. If few animals are affected or have been exposed to contagion, and it appears to be a fresh introduction into the country, it may be deemed advisable to slaughter the affected animals and those which have been in contact with them, or to declare the place in which the disease exists an infected area, to prevent movement of cattle and egress of animals of all kinds, causing attendants, etc., to be disinfected before leaving, and thoroughly disinfecting the place and everything which may possibly have been in contact with the diseased or their discharges. When the disease was rife in this country, prevention of movement, isolation of the affected, and in contact animals, washing at the mouth with some non-irritating disinfectant, walking through some disinfectant solution, were measures commonly adopted. This plan sometimes maintained the existence of the malady in a place for a considerable period, and some stockowners, not fearing fatal results, used to turn the affected and healthy together that all might contract the disease, from which they would nearly all recover, and thus get the trouble over more quickly.

Foot-rot in Sheep.—This disease is general and widespread, not only in Great Britain, but wherever sheep are kept under similar conditions. Though few veterinary subjects have been more discussed, especially as to whether contagious or not, the fact that foot-rot rarely proves fatal and in the majority of cases is not regarded as seriously affecting the health of its subjects, has served to detract from the importance which it deserves. Undoubtedly it is the cause of intense suffering, and materially affects the well-doing of sheep. The aggregate suffering and monetary loss associated with its existence render it worthy of careful consideration, especially in the direction of prevention. It must be confessed that much variety of opinion still exists as to the exact cause of the disease. The opinion most generally expressed appears to favour the view that foot-rot is a contagious disease, but all are agreed that it is

more common on wet lands and in rainy seasons. It is held by some flockmasters that the affection is usually introduced into fresh situations by sheep suffering from the disease. That is to say, there is a specific virus, which is the essential factor, and which does not exist on some farms, unless introduced from without, and having once gained admission to a flock spreads from sheep to sheep. Up to this time no specific virus has been demonstrated, and it is perhaps hardly safe to conclude from common observation that such exists. Direct experiments undertaken by ourselves have given results similar to those of others previously carried out, which force the conclusion that the occurrence of foot-rot, as usually met with in our flocks, depends to a large extent on other conditions, and that, if it is necessary to admit the action of a virus, there are other circumstances of even greater importance to be taken into consideration. There is probably more than one disease of the feet of sheep generally included under the head of foot-rot, but from a practical point of view it is not necessary that an attempt should be here made to distinguish between them. In order to gain correct views of the situation, it must be realised that the foot of the sheep is naturally adapted for use on dry plains and mountains, and that by constant travelling in such dry situations the skin and horn are preserved hard and resistant, and at the same time the wearing surface is kept in due proportion. In this state they resist the attack of micro-organisms, and the bearing of the hoof is level or at least natural. In situations, as the South Downs, when the above conditions usually obtain, foot-rot is comparatively rare, though even there cases are occasionally met with. In other situations, where opposite conditions obtain, that is where the land is soft and damp, or the herbage long and wet, the disease is rarely absent, almost always existing to a greater or lesser extent. It is, however, in rainy seasons and particularly in wet summers when grass is plentiful, as in that of 1907, that foot-rot is met with in almost all situations. It is also noticed to be prevalent after a prolonged period of heavy dews. Under such circumstances the skin above the horn, especially that in the cleft, and the horn itself, are softened and so rendered more vulnerable, the bottom of the foot is not kept properly worn down, as it sinks into the soil, the outer horn or wall becomes overgrown, and, as every shepherd knows, tends to curl inwards until it presses on the sole, or splits. The pressure on the sole causes pain and inflammation, micro-organisms enter, matter is formed, the horn becomes disintegrated, and the skin above red and inflamed. The sensitive parts become exposed and the sheep experiences pain at every step. This is often so great as to cause the animal to habitually go on its knees, sometimes, when affecting the hind feet, to drag itself along with the fore or to lie down persistently. The disintegration of the horn so affected by wet is in all probability brought about by micro-organisms, and insomuch as that, if these come into contact with horn in this condition, foot-rot is produced, then in the broadest sense the disease is contagious. However, from the very general distribution of the affection in wet seasons it seems highly probable that these germs must be very widespread, or what are termed common soil organisms. It is, also, quite conceivable that by the introduction of fresh affected sheep large numbers of such organisms may be brought on to places, and so the chances of others taking the disease may be thereby increased, while it is recognised that under varying circumstances micro-organisms may vary in potency and destructive effect. In practice we certainly find foot-rot of varying degrees of intensity, and the moisture so favourable to the occurrence of the disease is probably equally favourable to the multiplication of germs. It

is our own experience that this variation is more affected by conditions of dryness or moisture than by any special properties of germs which affect the skin and horn. In dry seasons comparatively little is heard about foot-rot. The symptoms of foot-rot are so well known as to call for little notice here. Unfortunately, lameness is often regarded as an early indication of its existence. Occasionally the skin, particularly that between the claws, first becomes red, hot, and painful, a condition sometimes termed "the scald" occurring in long wet grass. This induces lameness in the early stages, but the shepherd who depends on lameness as the first sign of foot-rot is likely to meet his cases in an advanced state of disease. Though foot-rot may show itself first in different situations, as, for example, a breaking away of the horn at the toe, or a condition above described in the skin between the claws, in a large proportion of cases an early examination will reveal an incurving of the horn of the wall towards the sole, and a softening or peeling of the sole. In more advanced stages the horn may be detached or hanging in flakes, growing out in soft tufts, blood vessels exposed and protruding, the whole discharging a disagreeable, fœtid matter, sometimes of a cheesy appearance. Occasionally a claw is removed, usually torn off, as there is no great tendency for shedding the hoof as in foot-and-mouth disease. The skin about the coronet, sometimes far up the limb, is inflamed and swollen. In warm weather maggots are frequently found "adding fuel to the fire," indeed in this exposed state the sensitive parts are liable to any infection, from some of which the animal may succumb. The disease is so general that its prevention should engage the attention of the shepherd at all times. Unfortunately, in wet seasons the task is not only difficult, but sometimes quite beyond his powers. Circumstances, which cannot be controlled, may favour the occurrence of the disease, but even under the most trying conditions well-directed efforts effect much good. The feet of sheep should be regularly and frequently examined, and any overgrown horn removed with a stout, sharp knife or nippers, so as to allow of a level bearing of the foot. In rainy seasons for sheep kept on heavy, wet land a daily walk on a hard road, by wearing down the hoof to proper proportions favouring the growth of sound horn, may prove of great service in preventing foot-rot and probably in curing some of the milder cases. If at any time there is discovered foot-rot or anything suggesting its existence, after paring the hoof some dressing of antiseptic nature may be applied, or the whole flock walked through the antiseptic trough. If such precautions are regularly adopted, the disease is usually kept in check; but when, as unfortunately is too frequently the case, it is only thought necessary to give the matter any consideration after the changes are advanced, foot-rot becomes the source of great annoyance and loss. Though from some individual peculiarities of sheep, the horn may become overgrown, the ends turned in, the skin at the coronet strained, and foot-rot established in a few cases, it most frequently happens that where precautions have not been adopted a considerable proportion of the flock is found affected. In large flocks it is often impracticable to dress each affected animal individually. Under such circumstances, after the feet have been carefully pared and diseased horn removed, the use of the trough is usually resorted to. This should be from 12 to 13 inches deep, and of any size suitable to circumstances. The solution should be deep enough to cover the hoof and lower part of the pastern, and the sheep allowed to slowly walk through or stand in it for about a minute. The materials used for the purpose are always poisonous, and care must be exercised to prevent any of the solution being taken by the sheep by their mouth. After passing through the

trough it is well to allow them to stand a few minutes on some hard ground before turning on to pasture. The solution remaining after use should be carefully kept inaccessible to animals. The materials most commonly used for this form of treatment are sulphate of copper, arsenic, or tarry preparation. That more generally favoured is prepared by mixing a pound each of arsenic and washing soda in 6 or 7 gallons of boiling water; another by dissolving a pound each of sulphate of copper, sulphate of iron, and alum in 6 gallons of water. Five per cent. of carbolic acid in water is also used, while some rely on the application of tar, sulphate of copper ointment; or a mixture of this with alum is often adopted for dressing individual cases. Very strong acids should be avoided, as such, when coming in contact with sensitive parts, cause great pain and sometimes irreparable damage to the foot. For severe cases, bandages or boots of leather, gutta-percha, or strong cloth are used to protect the exposed parts from injury and to maintain the medicinal application in position. The separation of the diseased from the healthy sheep usually renders curative treatment more easy, and while there remains room for divergent views as to whether the disease is mainly spread by contagion, such an arrangement will at any rate be on the safe side.

Forage Crops.—These crops differ from other crops on account of their being cultivated for their leaves, although in some cases the two classes of crops approach each other very closely. Common rape, for example, is very nearly allied to Swedish turnips, and in kohl-rabi we find a combination of leaves with a succulent stem. The turnip-rooted cabbages, Brassica, Carlo-rapa, is another example of the same kind. There is, as a rule, no difficulty in discriminating between root and fodder or forage crops. There is a difference in one class of forage crops in respect of the position in which they stand to corn crops.

Clover and grass, sainfoin, lucerne, Italian ryegrass, and many other seed plants are commonly sown among young corn, and can in no respect be viewed as following crops. On the other hand, vetches, winter-rye, barley, and oats, etc., are or may be treated as catch crops, *i.e.* they are cultivated on the fallow breadth and followed by roots. Forage crops may therefore be divided into the following classes:—(1) Those which are cultivated upon the same principle as root crops; (2) those which are employed as "catch crops," preceding or following a root crop; (3) those which occupy a similar place in rotation with grass-seeds; (4) those which occupy the ground for more than one year, and yield a perennial supply to green fodder.

Fodder crops form a numerous class, some of which figure for the most part only in books, and are little known to farmers. New fodder crops are constantly being introduced by enterprising seedsmen, and are sometimes little heard of in subsequent years. In treating of forage crops, prominence will be given to those which are widely appreciated by agriculturists in this country, and as many as possible of the less generally cultivated plants will be briefly noticed. It is inconvenient to follow a botanical arrangement, as there are gramineous plants which are cultivated for fallowing purposes, and leguminous plants which appear among natural grasses, or as cultivated fodder crops. The classification must therefore be based upon position in rotation and the methods of cultivation followed, and in accordance with this system we shall treat first of—

Fallow Crops cultivated on the same Principle as Roots Crops.

Rape, as seen in the forms of the Essex dwarf and giant varieties, is smooth-leaved, and botanically identical with the Swedish turnips (*Brassica campestris*). The difference between the two plants is not sufficient to make them specifically distinct, and consists in a development of root in the one and of leaf in the other. *Brassica napus*, or true Russian rape, is specifically different if only in the reticulated character of the texture of the seed. Rape is one of the most widely cultivated of the forage crops. It is very hardy, and may be sown in April and May for summer use, and in July and August for spring use. The cultivation and manuring are identical with turnip cultivation, it being a mere matter of choice whether rape or turnips should be sown. In many cases both seeds are sown together, giving a field of rape and turnips mixed. Rape is suitable for various classes of land. It is largely grown by sheep-masters both for summer and spring folds on the chalk hills of Sussex, Hampshire, Wiltshire, and other chalk-land counties. It is a favourite with clay-land farmers, as its strong top-roots force their way deeply into the soil and successfully resist drought. It has always been cultivated with marked success upon the fen-lands of East Anglia, where it is preferred to swedes, and produces quite as much fodder per acre. In a word, it suits all soils except the very poorest, where white turnips thrive better. It is very nutritious, so that fattening sheep ought to go straight to the butcher after feeding upon it. Rape has been known to maintain 400 sheep per acre for a week in the Fens, but upon chalky soils 200 per acre is thought satisfactory. It may be treated like turnips, and thereafter cultivation consists in harrowing the young plants and horse- and hand-hoeing between the rows. It grows rapidly under favourable conditions, and presents a luxuriant appearance when ready for stocking.

Thousand-headed kale was first brought into general cultivation through a paper read before the London Farmers' Club by the late Mr. Robert Russell of Farringham in Kent. It is bolder in the leaf than rape, and possesses a wonderful power of developing auxiliary buds and branches. It grows to a height of about five feet, and produces a globular mass of branching stems and leaves, if allowed sufficient space. In other respects, as in the cultivation of the ground, the methods of sowing, the appearance of the reed, and the after-cultivation, kale and rape are much alike. It may be sown in April and May for late summer keep, and in August for April keep. It is an excellent food for ewes and lambs in the spring, but is less nutritious than rape, and less likely to father lambs. It has been alleged to be fairly permanent, and to produce successive foldings; but in most cases it is once or twice put off, and then ploughed up for corn. It can be grown without singling, and this induces a compact growth of lower stature and greater tenderness. Its strong, deep searching roots are sometimes counted objectionable. They are difficult to plough up, and often require to be removed before the ground can be sown, and this may account for kale being more exhausting than rape.

Cabbages must be classed as forage crops, as they are entirely grown for their leaves. They are treated of in detail under a separate article, but in this connection are introduced as one of a large class of crops devoted to special uses. The cabbage forms an important food between the succeeding seasons, as, for example, during the period when grass is failing and dairy cattle are still out on the pastures. At all periods of scarcity an acreage of cabbage is of great service in tiding over difficulties

as to keep. They may be given to cows without imparting a disagreeable flavour to the milk, and they come in well for sheep in the height of summer. There are many varieties of cabbage adapted for different classes of land and of stock, among which may be mentioned the drumheads, sheep-folds, early and late savoys, sprouting broccoli. They are usually consumed during the summer, and are followed by wheat. Lastly, there is white mustard, a crop which can be, so to speak, extemporised in six weeks if turnips happen to fail, or if stubbles are cleared in time for sowing it.

The above are the principal cruciferous forage crops, all of which are allied to root crops, although they are sufficiently distinct to be separately classed.

Forage crops used as catch crops.—We shall next treat of the three cereals largely employed as fodder crops, and as an immediate preparation for roots. These are winter rye, winter barley, and winter oats, three forage crops which follow in succession from the earliest spring to June. Winter-rye, in some cases, *i.e.* when sown in August, is ready for consumption in December, but more usually after the severe weather has passed in March. It is the first green food after turnip and rape greens, and is fed in conjunction with heaped swedes or mangel-wurzel thrown about. The lambs run forward upon the green rye, and the ewes follow behind hurdles. When the rye is finished, or runs up into stalks, winter barley takes its place, and usually serves until trifolium is ready in May. *Trifolium incarnatum* must be mentioned as generally constituting a link between winter barley and winter oats, and the latter crop forms a link between trifolium and vetches. These various fodder crops are relied upon by sheep farmers in southern England to carry their sheep through the summer until rape, cabbage, and early white turnips are ready for folding, which again introduce the flock to winter food. (*See* Catch Crops.) The system of growing these crops is confined to the light land districts of the south, and sometimes interferes with absolute cleanness of the land. It cannot be carried out successfully on heavy land, neither can it be followed in the north of England and Scotland.

Forage crops sown upon corn.—This section includes grass seeds, clovers, mixtures intended for hay and grazing, and a large number of prepared crops, many of which have not advanced beyond this stage. An article on forage crops might be expected to deal with crops of this description, but special articles will be found upon most of the crops here named. If we consider "seeds" which occupy the third year of the Norfolk rotation, we see in them a forage crop of mixed character. The idea of forage, however, suggests green food cut and carried to buildings, or closely folded upon the land. Clover and grass seeds may be open-grazed or cut for hay, but appear conspicuously as forage crops when soiled in yards or folds. The cultivation of these crops is of the simplest character, as they are sown upon young corn, and harrowed and rolled in. There they remain as a sub-growth until harvest, when they are left in possession of the field. This is radically different treatment to that bestowed upon the forage crops previously mentioned. There is no opportunity for cleaning the land when it is under "seeds," but the effect is beneficent as regards fertility. For particulars of management, the reader is referred to special articles on each crop indicated.

Italian ryegrass not only forms a part of most mixtures of grass seeds, but is often grown alone as a forage crop. No plant deserves the name better, as it is capable of producing an extraordinary weight per acre, and

of repeated growth. It has been known to produce 70 tons per acre, and 13½ feet of herbage in total length, added together, in a single season. It is the most suitable plant existing for sewage irrigation, and may be relied upon in most situations for a supply of early keep. It responds freely to applications of nitrate of soda, Peruvian guano, and all nitrogenous manures, and stands repeated cuttings.

Sainfoin and lucerne rank high among our forage crops, and take us back to clovers and mixed seeds, because they also are sown on young corn. Lucerne is, however, often sown on specially cultivated ground, and entails a complicated cultivation. (*See* Lucerne.)

In order to deal exhaustively with the subject of forage crops, it would be necessary to discuss the merits of all the permanent pasture grasses. If we take Drs. Stebler and Schröter's standard work on *The Best Forage Crops*, published in 1889 (David Nutt, London), and translated into English by Professor A. N. M'Alpine, we find that rye grasses, cock's-foot, timothy grass, foxtail, meadow fescue, and fifteen other of the best grasses are thoroughly described, besides such leguminous plants as *Anthyllis vulneraria* (kidney vetch), ladies' fingers, bird's-foot trefoil, and *Galiga officinale* (goat's rue). According to this view of the subject, a study of forage crops would involve the study of all grasses, clovers, and innumerable herbaceous plants; and this would preclude the idea of considering the subject in its widest bearings within the limits of a short article.

There are still many plants which have been suggested for forage purposes, not mentioned by Stebler, but nevertheless worthy of notice. Among the most important of these is maize, which is cultivated with success in sheltered situations in southern England. The chief objection to maize is that it is susceptible to injury from even slight frost. It is sown in May, and has been grown with great success at Waters Place, Ware, by Mr. T. F. Buxton, who has twice forwarded to the writer of this article samples, 11 feet long. Chinese sugar-cane (sorghum) sold as broom-corn and as Minnesota amber cane has been known for forty years, but is little cultivated; Hungarian forage-grass or *Bromus inermis*, *Bromus Schrœderi*; gorse or whin (var. *Stricta*) is much used on poor land; buckwheat, burnet, chicory, serradilla, milfoil or yarrow, sheep's parsley, lupins, etc. etc. Some of these plants are generally esteemed, while others are neglected. One interesting point in connection with forage crops is the large number of natural orders they represent. There is no difficulty in naming at least twelve botanical orders which yield forage crops of esteemed value, among which we mention Græmineæ, Cruciferæ, Leguminosæ, Polygonaceæ, Labiatæ, Plantaginaceæ, Chenopodiaceæ, Polygonaceæ, Umbelliferæ, Rosaceæ, Compositæ, and Boraginaceæ. When we add to this formidable list many descriptions of foliage which are relished by cattle, and which might be included in a full list of possible forage plants, we see clearly the bearings of botany upon agriculture.

Looking at the entire subject, we find certain crops which may be relied upon in any average season, and capable of producing heavy crops on a wide range of soils. Others are suitable for dry and poor land, such as gorse, burnet, chicory, and yarrow, or for damp situations, such as comfrey, fiorin grass, and even Italian ryegrass. As to the comparative value of these plants, more depends upon the soil which produces them than their inherent nutrient value, and weight per acre may easily override a verdict based upon analysis. It is curious to note that some of the best pastures and meadows are composed of species of grasses which are classed as of low nutrient value. In some cases meadows enjoy a higher reputation for

producing hay of first-rate quality than the species which form the bulk of the herbage would lead us to expect. Even fattening pastures have been known to largely consist of Yorkshire fog, as the writer was informed by the late Sir John Lawes. The quality of the land affects herbage materially, and even root crops grown on some fields will fatten animals, while the same kind of roots grown on inferior land will almost starve them. The great point in growing forage crops is to secure a bulky return of fresh green herbage of wholesome character. It should be consumed young, or at the stage when it is just bursting into flower (*see* Hay-making). Some fodder crops are well suited for silage, some for hay, some for soiling in yards, and others for open grazing. If the writer has not been able to recommend certain species in preference to others, it is because he is aware of the enormous influence of soil and situation in determining the actual value of herbage. As one who has tried a large number of lesser known forage plants, he feels an increasing regard for those old friends which have stood the test of years and seasons. New forage crops which have been introduced with a flourish of trumpets have in many cases failed to stand the test, while others, such as maize, deserve further trial. Success depends so much upon circumstances; but with reference to maize, it is capable of attaining an extraordinary bulk, and is eminently fitted for cutting up and storing fresh as silage.

Forestry is the science of propagating and planting trees, and so managing them in all stages of growth as to make the soil yield, at a commercial profit, the utmost amount of fine timber or other forest products. It is also called Silviculture, to distinguish it from Arboriculture (*q.v.*), which is the art of cultivating trees for their botanical interest or their individual and collective beauty. The cardinal principle of forestry is continuity, secured by systematic rotation, whereby, as in agriculture and horticulture, one crop prepares the way for the next; but its application demands longer foresight than is required in these kindred sciences, seeing that the rotation is measured, not by seasons, but by generations of men.

It is scarcely an exaggeration to say that this great principle has never been recognised or acted on in the United Kingdom, although it possesses a soil and climate suitable for producing timber of the finest quality. By the time that the native forests had been cleared away, the development of coalfields made our people independent of wood for fuel; the excellence of our corn and pasture lands induced the Government to foster agriculture, and landowners preferred the quicker profits from that industry to the slower returns from their woodlands. Wheat rose to an exorbitant price during the great wars at the beginning of the nineteenth century; for thirty years after the abolition of the corn duties in 1846, various circumstances combined to maintain it at a high figure. When at length the effect of free imports began to be felt in 1876, much wheat land of inferior quality was thrown out of cultivation, and the value of first-class land fell heavily, by which time most landowners had ceased to regard woodland as a source of revenue and had taken no measures to preserve it, except as game covert and as agreeable furniture of a landscape. The use of iron in shipbuilding had become general during the latter half of the century; the "walls of Old England" were wooden no longer, and fine oaks, which hitherto had been in constant demand in the Navy yards, suffered a heavy fall in value. Meanwhile, the enormous development of manufactures had

caused a corresponding increase in the need for timber, especially of coniferous trees. In the absence of a regular home supply, consumers sent abroad for their material and the foreign timber trade grew to enormous dimensions. The following table shows the increase in the annual imports of timber to the United Kingdom during twenty years:—

WOOD AND TIMBER IMPORTS.

QUANTITY.

Description.	1886.	1905.	Increase.	Decrease.	Percentage.
Hewn—	Loads.	Loads.	Loads.	Loads.	
Fir	1,388,278	2,596,078	1,207,800	...	+ 86·9
Oak	95,178	145,663	50,485	...	+ 53·0
Teak	40,895	60,976	20,081	...	+ 49·1
Unenumerated	58,411	53,834	...	4,577	− 7·8
Sawn or split—					
Fir	3,554,769	5,797,922	2,243,153	...	+ 63·1
Unenumerated	231,017	188,604	...	42,413	− 18·3
Staves	130,717	119,182	...	11,535	− 8·8
Furniture Woods—	Tons.	Tons.	Tons.	Tons.	
Mahogany	48,732	95,548	46,816	...	+ 96·0
Unenumerated	50,717	197,111	146,394	...	+ 288·6
Wood pulp	117,663	578,012	460,349	...	+ 391·2

DECLARED VALUE.

Description.	1886.	1905.	Increase.	Increase per cent.
Hewn—				
Fir	£2,191,254	£3,495,523	£1,304,269	59·5
Oak	540,242	875,875	335,633	62·1
Teak	498,257	876,654	378,397	75·9
Unenumerated	192,483	225,753	33,270	17·2
Sawn or split—				
Fir	7,813,046	14,469,574	6,656,528	85·1
Unenumerated	392,446	785,756	393,310	100·2
Staves	532,117	553,092	20,975	3·9
Furniture Woods—				
Mahogany	402,935	820,995	418,060	103·7
Unenumerated	407,562	1,170,798	763,236	187·2
Wood pulp	724,955	2,759,627	2,034,672	280·6
Total value	£13,695,297	£26,033,647	£12,338,350	90·0

In this return no account is taken of wood-pulp in the form of boards, dye woods, tanning material, and certain other forest products, such as tar, turpentine, resin, etc.

Of the timber imported into this country, between four-fifths and five-sixths is coniferous wood, which all experts agree in pronouncing capable of being produced in the British Isles. It may appear that, so long as the wants of British industries are met by foreign supplies, it matters little to the consumer where the timber he buys is produced. But the public sense is awakening to several circumstances which render the development

of our forest resources a matter of urgency. The first of these circumstances is the rapid expansion of timber-consuming industries in foreign countries, especially Germany and the United States, coupled with the shrinkage of the visible and accessible supply. Thirty years ago Germany was a large exporter of timber; now she not only consumes all the timber grown in her own forests, estimated at an annual value of £22,000,000, but imports from other countries nearly 5,000,000 tons per annum, valued at about £15,000,000. In like manner the United States, whence we drew large supplies in former years, have practically no surplus over what is required for their home industries. We are face to face, therefore, with the state of things described as follows in the report of the Departmental Committee appointed in 1902 to inquire into the condition of British forestry:—

"The world is rapidly approaching a shortage, if not an actual dearth, in its supply of coniferous timber, which constitutes between 80 and 90 per cent. of the total British timber imports."

The degree in which the forestry resources of the United Kingdom have been neglected may be seen from the following table showing the woodland areas of some of the principal European countries:—

Country.	Woodland Area.	Percentage of Woods to other Land.	Woodland Area per Head of Population.	Percentage of Woods owned by				
				State or Crown.	Private Owners.	Church and other Endowed Bodies.	Municipalities and Village Communities.	Corporations.
	Acres.							
Sweden	45,061,984	44·4	9·36	19·9	80·1	...	...	...
Finland	50,359,471	38·0	25·77	71·1	18·9	...	...	...
Russia	447,592,405	36·0	4·58	60·3	29·7	...	...	...
Austria	24,150,215	32·6	1·00	6·5	71·8	7·1	14·9	0·2
Hungary	22,683,469	28·3	1·27	16·0	41·3	6·6	18·5	17·7
German Empire	34,734,123	25·8	0·66	32·9	47·5	1·3	15·6	2·3
Norway	19,280,820	24·0	10·56	12·5	84·8	2·7	...	...
Turkey, Bulgaria, Bosnia, and Herzegovina	15,613,830	22·2	3·50	...	...	...	...	...
France	23,360,062	17·7	0·56	11·1	66·5	22·5	...	...
Spain	20,955,480	17·0	1·27	82·2	17·8	...	...	...
Belgium	1,205,830	16·6	0·10	...	...	...	...	...
Italy	9,030,320	12·0	0·32	3·8	53·8	43·0	...	...
Holland	568,100	7·0	0·10	...	...	...	...	...
Denmark	508,298	5·4	0·25	...	...	...	...	...
Portugal	1,165,346	5·1	0·25	...	...	...	...	...
Great Britain and Ireland	3,029,139	3·9	0·07	2·3	97·7	...	...	...

From this it appears that the United Kingdom, with 3,029,139 acres of woods and plantations, has a smaller proportion of its total land area, of 75,520,968 acres (exclusive of water), under woodland than any other European country. Commercially, its poverty in this respect is even greater than the figures show, because in the great majority of these woods, timber production is only a subsidiary object, their main purpose being game-covert, ornament, or shelter. In order to encourage undergrowth for harbouring game, the trees are habitually over-thinned, which renders impossible the production of clean, marketable boles, and they are so commonly planted in strips, clumps, and comparatively small masses, that it is the exception in most counties to find 50 acres of contiguous wood.

Disposed in this manner, woods suffer terribly from storms, for 1000 contiguous acres of forest offer far greater resistance to wind than 1000 acres scattered irregularly over an estate of 10,000 acres. The commonest objection urged against forestry enterprise in the United Kingdom is the supposed peculiar violence of our gales; but in fact it is the general treelessness of our islands which lends these gales their destructive force, for there is no reason to suppose that they are more furious or frequent now than they were 2000 years ago, when all our inland region and much of our seaboard were clothed with dense, primitive forest.

Another objection commonly raised against the establishment of forests in the United Kingdom is founded upon the unsatisfactory returns from our existing woodlands. Landowners complain that they cannot dispose of fine timber even when it is offered for sale; but this is the result, partly of irregularity in supply and partly of the coarse quality of timber grown in woods which have been too severely thinned. The timber trade, like every other, requires a regular business connection between producer and consumer.

The owner of a woodland must not expect to drive a profitable bargain if he consults only his own convenience, which may cause him to offer fifty trees one year, five thousand the next, and none in the third. Purchasers will go to those places where timber can be as regularly supplied as any other crop. Moreover, railway rates, which tell so heavily on the home timber traffic, can never be lowered to the scale charged upon foreign timber until the requirements of the home trade have become as regular as those of the foreign trade.

Even under the uncertain conditions affecting the market for home timber, it is possible to obtain remunerative prices for well-grown wood, as shown by the following extract from a report from Derbyshire (*Quarterly Journal of Forestry*, April 1907, p. 185):—

"The demand for oak, ash, larch, and sycamore of good size seems to exceed the supply, while good beech and elm are also in request. Prices rule as under—

Larch, fair size and good quality . .	1s. to 1s. 2d. per foot.
Oak, fair trees, 30 feet average . . .	1s. 4d. to 1s. 6d.
Ash, „ 20 to 30 feet average . .	1s. 4d. to 1s. 6d.
Elm, according to quality	8d. to 10d.
Sycamore of good size, according to quality	1s. and upwards.
Beech, first size and quality . . .	10d. to 1s. per foot.
„ second size and quality . . .	8d. to 10d. „
Scots pine	6d. „
Spruce	6d. „

The demand for pitwood is practically inexhaustible while coal continues to be raised; yet the report on the Home Timber Trade in the same number of the *Journal* contains a warning as the consequence of bad forestry:

"It is found for pitwood purposes, once the colliers in any pit have the handling of foreign pit timbers, that the managers seldom change back to English grown, because the former is so much pleasanter to handle, owing to its comparative freedom from roughness and knots."

Except for pitwood, immature wood is practically unsaleable in this country, where wood fuel is not in request. Much of it would serve well for the supply of wood pulp and cellulose mills, but the very few of these which have been set up in the United Kingdom import the bulk of their

raw material from the Baltic, costing them about 7d. a foot. No doubt their managers would prefer to get a supply nearer home; but there are no British woods capable of producing a sufficient quantity to keep the works going. The weekly requirements of a cellulose factory amount to 240 tons = 12,000 cubic feet (12,000 tons = 600,000 cubic feet per annum), equal to the total yield of 120 to 150 acres of spruce fir. To maintain this supply, from 4800 to 6000 acres of fir wood must be kept in rotation. Cellulose is obtained by chemical treatment of wood pulp, and must be manufactured in large quantity; but wood pulp, given a regular supply of suitable timber, may be produced on a far smaller scale. The demand for both substances, but especially cellulose, is practically inexhaustible, as they have become the almost universal substitute for rags in paper-making. The first pulping mill was started in Saxony in 1854, the first cellulose factory in 1874. In 1905 there were more than 600 pulp mills in Germany consuming 36,000,000 cubic feet of wood annually, and 71 cellulose factories consuming 30,000,000 feet, besides many of both in Austria, Norway, and Sweden (Nisbet's *Forester*, i. 85, ii. 581).

The provision of material for cellulose deserves attention from those municipalities which have started or are contemplating forest enterprise on the catchment area of their water supply; but it must be borne in mind that wood for this purpose must be clean grown and free from knots. Spruce is the tree most in favour for cellulose; silver and Scots pine are also used; among broad-leaved trees, lime, aspen, and poplar are easy to grind.

In view of the growing necessity for an ample supply of mature timber for all our principal industries and of the disappearance of the chief foreign sources of that supply, it seems but common prudence to prepare to follow the example of other nations so as to provide for our own requirements.

Having satisfied ourselves that the British soil and climate are peculiarly favourable to tree growth, it is natural to inquire into the extent of waste-lands available for forest enterprise.

Mr. Nisbet (*The Forester*, i. 95), having rigidly excluded all ground higher than 1000 feet above sea-level and all bog and wet land, presents the following estimate of the *minimum* extent which might be planted with good prospect of profit:—

	Waste Land.	Extent of Waste suitable for Planting.
	Acres.	Acres.
England	2,305,823	461,164
Scotland	9,374,512	1,874,902
Wales	1,250,813	250,162
Ireland	3,779,640	755,928
Total . .	16,710,788	3,342,156

Besides this may be reckoned a considerable part of what is returned as "Grass Lands" in the tables issued by the Board of Agriculture—poor pasture, rented at 1s. an acre or less, which is quite as capable of being converted into forest as the waste lands of Germany have been and are being converted by the State. And it is the State which we must look to in this country for the restoration of productive forestry, seeing that private landowners, with the best intentions possible, can seldom afford the necessary lock-up of capital during the unremunerative early years of a woodland.

Moreover, *the State pays no death duties*, and is thereby free from a burden which may destroy all margin of profit in the cultivation of trees.

It is gratifying to note that some of the great municipalities in the north of England have begun to plant on economic principles the lands which they have acquired as catchment areas for their water supply. These areas have to be kept clear of agriculture and, to a large extent, of grazing, in order to preserve the purity of the water. They form, therefore, tracts of waste land, and cannot be turned to better account than the cultivation of timber. The work has been undertaken on sound principles, Liverpool having already (in 1907) planted 640 acres out of the 22,000 acres which is in the hands of the municipality.

In resuming forestry enterprise it is to some Continental State that British planters have to turn for example and guidance, and no better model can be followed than that of the German Empire. The State forests of Germany extended in 1903 to 9,848,000 acres, and are constantly being added to by the purchase of waste lands. The net annual revenue from these forests during the five years 1877–81 averaged £4,280,400, equal to a clear profit annually of 8s. 6d. an acre. In the five years 1892–96 the net profit had risen to £5,416,600 = 11s. an acre. It is almost impossible to name any woodland, whether Crown property or private, in the United Kingdom, which has been so managed as to furnish comparison with these figures. The balance-sheet of the Office of Woods and Forests is no guide, as the greater part of the Royal Forests are maintained as public or private pleasure ground and landscape garden, which naturally results in a heavy deficit. The same system prevails on most private estates, making it almost impossible to find one showing a trustworthy balance-sheet. To do so it would be necessary in most cases to estimate the annual loss caused by rabbits alone, and the expense of protecting young woods against them, and to credit the forester with the value of these brutes in sport and for consumption. Trustworthy returns of British forestry, national or private, can hardly be obtained, for the simple reason that British forestry scarcely exists. There is, however, the oft-quoted example of the Novar woods in Ross-shire, the balance-sheets of which as furnished from the estate office have been published, showing the profit and loss account upon 3670 acres of woodland for the five years 1895–99. After debiting the account with all working expenses, grazing rent, fire insurance, etc., there is shown an average annual net revenue of £2024 = 11s. 1d. an acre—almost exactly corresponding to the revenue earned from the German State forests. The estate of Novar is distinguished from almost every other private property in this country by the fact that successive proprietors continued planting and clearing *on a regular system* from 1800 to 1850. Had this continued without interruption we should have had an example, unique in the United Kingdom, of an extensive woodland planned for progressive yield and renewal. Unluckily the system was suspended between the years 1850 and 1881, being resumed in the latter year by the present proprietor, Mr. Munro Ferguson, M.P. The present working plan provides for the current revenue being maintained, except so far as thirty-one years of neglect must affect the returns during a corresponding period in the future.

The nursery.—No planting, however moderate in extent, should be undertaken without previously providing a home nursery; for whether the young trees are to be raised from seed, which in extensive operations is almost imperative, or whether they be purchased of a size suitable for planting out, some ground must be prepared for their reception,

however temporary. There is a third method, namely, to purchase one or two-year-old seedlings, to be grown until they reach the size necessary for planting out.

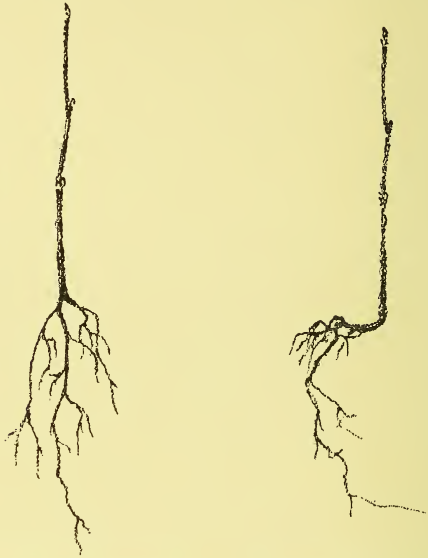
In forming a nursery, the general character of climate and soil must be taken into account. Provision for the need of young plant growth is very different on a hot, dry soil from that on a cool, moist one—in the south of England from that in Scotland and the west. Low, damp sites are to be avoided everywhere, as seedlings of many trees which are quite hardy in after-life suffer badly from frost in such situations. The other extreme —exposure to parching winds—is everywhere undesirable. Speaking generally, the best position is open ground on a deep, free soil, gently sloping, protected, but not overshadowed, by woodland on the side of the windy quarter. It is better that the soil be too light and sandy than too heavy.

The extent of ground to be enclosed depends on that of the area to be annually planted. Mr. Nisbet's estimate is a useful one, namely, that the permanent nursery should amount to 4 or 5 per cent. of that area. Thus for planting 50 acres in each year at 4 feet $\times$ 4 (2722 plants per acre $\times 50 = 136{,}100$ plants) 2 or $2\frac{1}{2}$ acres would suffice. If this does not suffice, temporary nurseries may be formed for raising seedlings. A convenient way of doing so is to enclose small portions of the ground that is being planted, trench them, and, when the young plants are ready for removal, leave as many of them in the beds as will fill up the blank in the new wood.

Nursery ground must always be trenched to a depth of 2 feet, the surface levelled and laid out in rectangular beds. If the soil is poor or very light, well-rotted leaf-mould or pulverised peat may be added, with lime; but strong manures are not expedient. A little basic slag may be added when transplanting from the seed-beds; this gives young trees a vigorous start, and encourages root-formation. Small seed may be sown either broadcast or in drills, the latter being preferable for convenience of weeding. Large seeds, like acorns or chestnuts, and some of the pines, should be dibbled in rows marked by a garden line 12–15 inches between the rows and $1\frac{1}{2}$–3 inches between the seeds, according to their size. Most seedlings require to be raised at a year old and *pricked out* in lines on fresh ground. Spruces, however, generally remain two years in the seed-bed, and ash, holly, and a few other seeds lie a whole year in the earth before germinating. The whole future of the projected woodland depends upon the manner in which seedlings are pricked out, and upon the subsequent handling of the young plants when transplanted in the nursery. A garden line is stretched along the bed for the reception of the seedlings, and a trench opened along it 8 or 9 inches deep, or deeper, if the seedlings have long roots. The utmost care is necessary to place the seedlings so that their roots are fully extended. Coniferous trees, especially, never recover the malformation caused by pricking out or transplanting in too shallow a trench. The consequence with broad-leaved trees is not so disastrous, but they should not be submitted to this unnatural treatment. On the other hand, neither seedlings nor transplants should be set too deep, or fresh roots will be thrown out, especially by conifers, at the collar or old ground level, and the plants will never recover normal growth. The plants, whether seedlings pricked out, nursery transplants, or young trees planted out, should be set so that the earth stands at the collar or original level on the stem. British nurserymen are too apt to send out young trees with roots malformed by ignorant or careless transplanting, an operation often

intrusted to women and children who know nothing about plant life, and whose sole object it is to get so many thousand seedlings set out in a day.

Transplanting.—After young plants have stood one or two years, according to their rate of growth, in the nursery lines, it is generally advantageous to transplant them again before planting them out in the open. The object of this is both to allow room for aerial growth and, which is more important, to stimulate the formation of root fibre. In the second transplantation the proper disposition of the roots in the ground is even



Forest plant properly transplanted. Forest plant improperly transplanted.

FIG. 1.

more important than in pricking out seedlings (Fig. 1). This, and the subsequent establishment of the young tree in its permanent position, are the two most critical moments in the whole life of the woodland, and, sad to say, it is at these very periods when British foresters and nurserymen are often most grievously at fault. At the second transplanting, oak, ash, and other broad-leaved trees which form long tap-roots should have the ends of these cut off to encourage the formation of fibrous rootlets.

The terms used by British nurserymen to denote the age and condition of their stock differ from those employed by continental growers, as follows:—

British.		French.
1 year 1 year, *i.e.* 2 years old; transplanted into rows	=	2 years transplanted.
2 year transplanted, *i.e.* 3 years old; 2 years in the rows	=	3 years transplanted.
2 year 2 year, *i.e.* 4 years old; twice transplanted	=	4 years transplanted.

The pricking out, transplantation, and final planting out of conifers should be deferred till spring, but broad-leaved trees may be handled so soon as the young wood is ripe in autumn.

Throughout these operations it is of the utmost importance to prevent the root fibres getting dry. In fact, one of the chief advantages of a home nursery consists in avoiding the almost inevitable drying of the roots during transit from a distance. Seedlings should be tied in bundles according to size, the sorting being done under cover, and kept under wet sacking while pricking out is going on. Larger plants may be "sheughed" into a temporary trench in a shady place near the ground to be planted, and no more should be brought on the ground than the workmen can handle in a day.

Planting the woodland.—The method of planting will depend on the nature of the surface and of the soil. On light porous soil, with a naked surface, one or two-year-old seedlings may be dibbled or small transplants notched in. This is the cheapest of all modes of planting, but in the humid climate of these islands it is one that can very seldom be adopted, owing to the rank growth of herbage which springs on all but the most barren or dry land. It will succeed best where a thick crop of spruce or

Fig. 2.—Unnatural position of Roots.

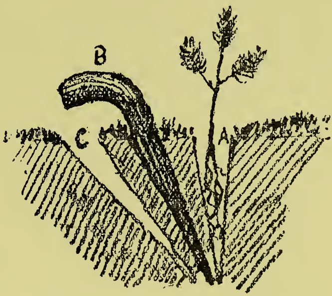


Fig. 3.—German Planting-Stick.

beech has been removed, leaving the surface bare, remembering that conifers must not be planted in immediate succession to conifers, owing to the pine beetles breeding in the old stumps.

Old pasture should be broken with the plough before attempting to plant it, and will be all the readier to receive young trees if a crop of grain is taken off it, and the stubble ploughed in. Trenching would be even more effective, but is out of the question owing to the expense. Ground of a very free character, prepared by twice ploughing, may be planted with 1 year 1 pine, larch and beech by *notching*, that is, making L or T shaped incisions in the soil, pressing down the spade-handle to open the cut, and inserting the young plant at the angle, and treading the ground moderately firm about it. But even on the lightest soil, it is difficult to ensure care on the part of planters to avoid leaving the roots in the unnatural position shown in Fig. 2.

Preferable to the spade is the German planting-stick (Fig. 3), made of iron, or wood heavily shod with iron. Driven in vertically at A, it is then withdrawn and the seedling is lowered into the hole; next, a diagonal thrust is given at B and the soil pressed close up to the plant; the second opening being then closed by another diagonal thrust at C. But even this

will only succeed on friable soil. In most cases *pit-planting*, though more expensive, is the more profitable in the end. Larger plants are used for this method, three, four, or five years old according to the species, and placed in holes previously opened with the spade, and with the mattock on unploughed ground, to the full depth required by the roots. Constant watchfulness is necessary to ensure that the workmen spread the roots evenly in the pit. The upper turf should be replaced upside down, the best soil having been heaped in next to the roots of the plant.

If the "tilth" or upper soil is very shallow, resting on an impervious subsoil of boulder clay or rock, *mound-planting* must be resorted to, a

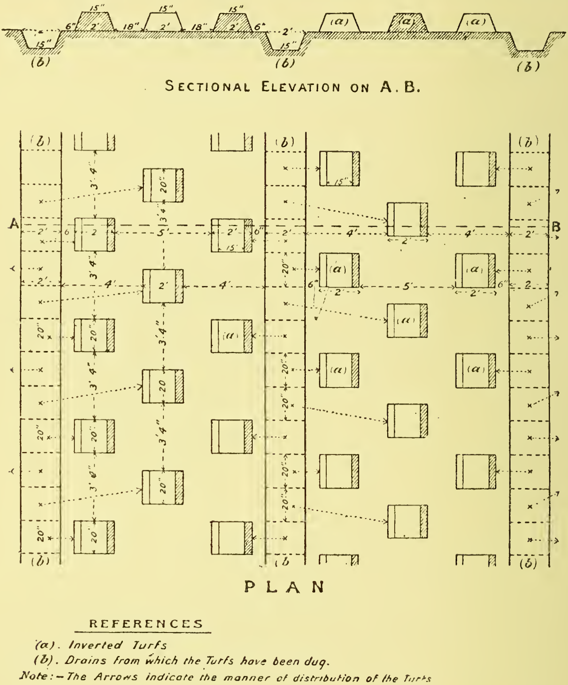


FIG. 4.—Wet Moorland prepared for Planting on the Belgian System.

method which has been successfully applied by the Belgian Government to the planting of peat land to an altitude of 2000 feet. The process is to cut surface drains 2 feet wide and 12 feet apart, placing the turfs face downward as shown in Fig. 4. They are left so for a year, when a hole is cut in each with the instrument represented in Fig. 5, for the reception of the young trees. "The extra expense [of this process] is partly made up by the use of smaller plants, which soon outgrow larger plants which have been notched into natural surfaces five or six years earlier" (Sir J. Stirling Maxwell in *Trans. Roy. Scot. Arbor. Soc.* vol. xx. part 1).

In most cases in the United Kingdom it will be found most profitable

to rear young trees in a nursery and to plant them out when they are of a size to compete successfully with the ground herbage which, in the moister parts of the island, is usually so rank. But whereas the best trees are those grown in the spot where they are sown, every advantage should be taken of natural regeneration of desirable species where that takes place, and occasionally, but rarely, the land may be successfully sown with seed of trees to form the future woodland. In the southern and midland counties of England oak reproduces itself in extraordinary abundance where protection is given against rodent and browsing animals; but in the north and west its seedlings, which have subterranean cotyledons, are generally smothered by herbage. Beech fares better, but not so well in the north as birch, ash, and sycamore, which in many Scottish districts may be reckoned on to fill ground from which timber has been cleared. The English elm, once planted, reproduces itself indefinitely by suckers. Among conifers, the Scots and Corsican pines produce many seedlings, especially where the ground cover is heather; so does the silver fir, which is a shade-bearer; but in Britain spruce must always be planted, although a shade-bearer, being so slow in growth during the first two years. The light-demanding larch reproduces itself in favourable places, but the undergrowth is generally too strong for it.

On the whole, natural regeneration, which is encouraged and regulated in France and Germany by successive fellings, can be regarded only as an occasional, and more or less accidental, process in the United Kingdom, of which advantage should certainly be taken when it offers itself. The prevalence of rabbits, almost universal throughout the British Isles, makes it difficult to judge in what degree natural regeneration might take place were that plague dealt with as it should be, and as it must be, if forestry is ever to be a profitable business.

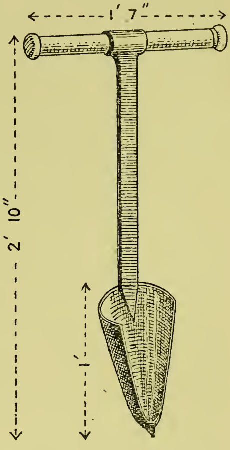


Fig. 5.—Planting Tool used in Belgium.

The cross handle is of wood—the rest of iron.

The same conditions of soil and climate, so favourable to rank growth of herbage, as militate against natural regeneration, offer considerable obstacles to rearing woods by sowing seed on the ground they are to occupy. On the Continent it used to be more commonly practised than planting, but has been generally abandoned, at least for conifers, except where the surface of the ground is specially favourable, in favour of setting young seedlings by notching. Sowing, if the results were equally satisfactory, would certainly be preferable to planting, owing to the less initial expense; but that advantage disappears when labour is necessary to prepare the surface; added to which is the risk of losing the seed by birds, mice, etc., especially in the case of large seeds such as acorns or beech mast.

What to plant.—In planning a woodland, the choice of trees should be made with regard to (1) the species most suitable for the soil, climate, and exposure; (2) the kind of timber most likely to be in demand when the woodland is mature. The old wasteful system of indiscriminate mixture is pretty well discredited now, and the first of these considerations may be dealt with in the light of information contained in the articles headed Ash,

Beech, Fir, Pine, etc., having due regard to the results of local experience, which should never be disregarded, however carefully it may be checked.

The second consideration—the probable prospective value of different kinds of wood—must be largely speculative; but it may be safely assumed that, although substitutes may be found for certain kinds of timber, such as sycamore, at present of exceptional value for special purposes, the general tendency of prices will be towards a rise, owing to increasing consumption and a diminishing supply.

Species.	Rotation.	Yield per Annum per Acre in Cubic Feet.	Present Average Price per Cubic Foot.
Conifers.			
Douglas fir	50 to 80 years	50 to 100	6d. to 9d.
Larch	40 ,, 80 ,,	40 ,, 60	9d. ,, 1s.
Corsican pine	70 ,, 100 ,,	40 ,, 80	6d. ,, 8d.
Weymouth pine	80 ,, 100 ,,	40 ,, 70	6d. ,, 9d.
Scots pine	70 ,, 100 ,,	30 ,, 60	4d. ,, 8d.
Spruce	60 ,, 100 ,,	40 ,, 80	4d. ,, 9d.
Hardwoods.			
Ash	60 to 80 years	30 to 60	1s. 6d. to 2s.
Spanish chestnut	40 ,, 60 ,,	40 ,, 60	9d. ,, 1s.
Beech	70 ,, 100 ,,	40 ,, 80	6d. ,, 9d.
Oak	80 ,, 120 ,,	20 ,, 40	1s. ,, 2s.

The following table, based on Dr. Schlich's report on the German yield-tables, may be of some use as a guide in estimating prospective profits (*Trans. Roy. Scot. Arbor. Soc.*, 1904, p. 193). The prices are added from Mr. Nisbet's estimate (*The Forester*, i. 406 note), and are applicable to a country where all small wood is saleable as fuel or as material for pulping mills and cellulose factories, sources of demand which do not exist in Great Britain:—

Kind of Tree.	Average Period of Rotation.	Present Average Price per Cubic Foot.	Average Production of Timber per Annum per Acre.	Average Annual Increase in Value per Acre. £ *s.* *d.*
Larch	70 years	1s.	73 cubic feet	3 13 0
Scots pine	80 ,,	9d.	70 ,,	2 12 6
Spruce	90 ,,	6d.	84 ,,	2 2 0
Silver fir	120 ,,	6d.	111 ,,	2 15 6
Ash	70 ,,	1s. 6d.	40 ,,	3 0 0
Oak	130 ,,	1s. 6d.	46 ,,	3 9 0
Beech	120 ,,	1s.	57 ,,	2 17 0

Mr. A. C. Forbes has supplied another estimate of the quantity and value of timber produced annually on an acre by different kinds of tree (*English Estate Forestry*, p. 48).

Management of young woods.—Protection against hares and rabbits cannot be dispensed with in most parts of the United Kingdom, and adds very seriously to the cost of planting. To reduce the amount of wire-

netting necessary for this purpose, and to save labour in erecting it, the season's planting should be arranged, if possible, in a single rectangular area. After three or four years the wire-netting may be removed and used for another planting. For two years, sometimes three, after planting, the young trees will require relief by the sickle from grass and rank weeds. After that, the main object should be to maintain a close canopy of foliage so as to discourage lateral branch growth, to protect the soil from rapid evaporation, and to encourage the formation of humus or forest soil from the annual leaf fall.

In mixed plantations, the management will depend upon what the ultimate crop is to be, a matter which should be kept in view from the first. For instance in a mixed wood of oak, beech, and Scots pine, the pine will mature fifty years before the two others, which will require some assistance in the struggle for existence during the first twenty years. Clear head-room must be secured for the oaks, in some cases by the removal of some of the pines, in others by side-pruning the pines. Drastic thinning of the whole plantation, as recommended by British writers on forestry of the nineteenth century and still prevalent in almost all parts of our country, ensures the ruin of the woodland for every purpose except game covert and shelter.

In pure forest of a single species, such as Scots pine, Sitka spruce, Douglas fir or Corsican pine, or in forest composed of different trees equal in rate of growth and demand for light, thinning during the first twenty years should be confined to the removal of suppressed or diseased trees, the object being to maintain the maximum number of trees per acre consistent with vigorous health. It is only in this way that clean boles and marketable timber can be produced. After the boles have formed, gradual felling may be commenced, still maintaining the general canopy of foliage, until there remains on the ground only those trees which are intended for the final fall at the close of the rotation.

"The *first* thinnings (of pure forest) at fifteen to twenty years of age (according to the demand for light) will usually remove $\frac{1}{4}$ to $\frac{1}{2}$ of the original crop (2722 trees at 4×4 feet). A *second* thinning will usually be necessary about five years later, and a *third* thinning about other five years later, when there will probably be at twenty-five to thirty-five years of age (for light-demanding and shade-demanding crops respectively) only from 700–900 and 1000–1200 stems per acre on the average in Britain, although the stock might usually be quite well maintained at 800–1000 and 1200–1500 per acre respectively. After that the later thinnings may have to be repeated at intervals of five or ten years, according to circumstances. The work should be done methodically, a regular plan of weedings and thinnings being forecast by the forester and worked up to year by year, so as to go over, say, $\frac{1}{10}$ of the middle-aged and older woods each year, and $\frac{1}{5}$ of the pole-woods and young tree crops. After about forty to fifty years, little or no thinning is required in conifer crops, except merely to remove moribund and sickly stems. The thinning of mixed woods must be conducted on a different principle from the thinning of pure woods. To save oak, ash, or larch, it may often be necessary to fell more vigorous poles of other, but less valuable, kinds, which are interfering with or threatening to dominate them" (Nisbet's *Forester*, i. 440).

The cardinal rule in managing a growing wood is to allow each tree head-room for vertical growth and a moderate crown, maintaining a continuous canopy of foliage to prevent the development of side branches.

In the early stages of growth, timely attention should be given by the

removal of superfluous leaders and side branches. Every branch allowed to remain and die upon the bole makes an ugly knot in the timber, the dead wood being incorporated in the living wood, and seriously deteriorating its value (Fig. 6).

Management of older woods.—When a plantation has reached the age of forty or fifty years, the system of management has to be modified. By that time the height of bole will have been determined, for, although trees of most kinds may greatly increase in stature after forty years of age, especially in sheltered situations, in economic forestry it is more profitable to develop the boles already formed than to increase their length. Thinning must now be directed to encourage moderate crown development, without sudden sacrifice of canopy. As a rule, broad-leaved trees should receive more room for crown-formation than conifers require. An ample crown produces wide annual rings in the wood, which is desirable in broad-leaved timber, because narrow rings mean an excess of spiral vessels, to the detriment of the timber. On the other hand, the best coniferous timber is that composed of narrow annual rings. Generally speaking, therefore, a forest of pine or fir should be maintained with 35 to 50 per cent. more trees on the acre than one of oak and beech.

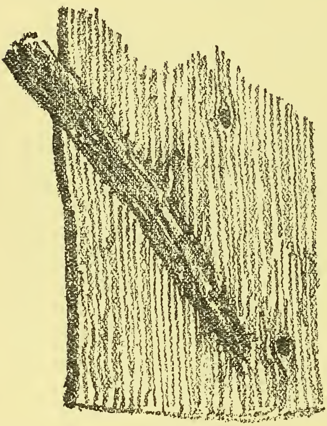


Fig. 6.

For the profitable management of a woodland, whereof the rotation must run into centuries, a *working plan* is as necessary as it is in farming, where the rotation is measured by seasons. It is a rare exception in the United Kingdom to find any such plan in operation, except as regards coppice, formerly the most remunerative form of forestry in England, but now difficult to conduct at a profit. It is very different in Germany, where a working plan is considered indispensable; where, moreover, even private woodland is subject to legislative forest control, restricting the owner from such felling as may expose his neighbour's woods to wind-damage, and imposing regulations as to shelter belts, etc.

No such recognition of neighbourly duty exists in the United Kingdom; every landed estate being self-contained. Even were two neighbouring owners to agree upon a mutual plan, they could not bind their successors, and the scheme might fall to pieces. This condition of things makes it very difficult to fix a working plan for any except very large estates; and even on these the usual arrangement of woods in belts and small masses does not facilitate systematic treatment.

In order to put things on a better footing, an expert should be employed to report and to draw up a scheme. Amateur enterprise merely ensures mistakes, the result of which will not be apparent for many years after it is too late to rectify them. The commonest difficulty in the way of starting a working scheme is the condition of existing woods. These may either be all of one age—old, young, or middle-aged—or of various ages

without that successional relation to each other which it is the object of a working scheme to secure. The expert, called upon to advise the establishment of a right system, will probably recommend the progressive clearance of most of the old woods, replanting the ground, and throwing detached plantations together so as to form larger contiguous areas. With such a process sentiment and æsthetic considerations are very apt to interfere, but these must be kept firmly in check, unless arboriculture, not forestry, is the object in view. The forester's object is to arrange the woodland in compartments which shall mature successively; and, when the working plan has been finally settled and approved, it should be entered in a volume wherein all future operations shall be recorded. Many landowners are deterred from putting their woods upon a sound system, owing to the expense entailed; but the cost of planting and of altering fences can be covered in most cases by the sale of timber from the ground cleared.

"The individual estate proprietor," says Mr. Forbes in a notable passage, "is at a disadvantage with respect to working plans, owing to the fact that he usually stands practically alone in his particular district. If the woodland proprietors of a certain district could agree to work their woods as a whole instead of as distinct units on each estate, they could command the market to a much greater extent than is the case now. The timber cut in each district would be regulated to meet the local demand, instead of any rise in the market being met by a simultaneous fall of timber over the whole district, resulting in the market becoming glutted in the course of a couple of months. . . . Hardly a sale takes place at which some agreement amongst buyers is not arrived at, by which one is prevented from bidding against another. But one rarely hears of any counter-agreement amongst timber sellers which prevents the market being overstocked" (*English Estate Forestry*, p. 195).

Co-operation among woodland owners is a counsel of perfection which it only requires moderate acquaintance with country life to recognise as unlikely to be carried into effect; but it may be observed that were such co-operation possible, and were it carried so far that a group of neighbouring proprietors registered themselves as a trade company, they could not only afford to pay the salaries necessary to secure a first-rate staff, which very few individual proprietors can do at the present time, but their property would escape the incidence of periodical death duties, which soon eat away the prospective profits of growing wood.

In no part of the United Kingdom will the adoption of a working plan cause such a drastic reform in management as in the southern counties of England, although, strange as it may seem, it is only in these, and in such other districts where the system of coppice-with-standards prevails, that a working plan has been in operation for centuries. Coppice is worked on a simple rotation, cutting the underwood at fixed intervals of ten to twenty years, and there was no more profitable method of forestry so long as the demand for that class of produce continued steady and good. But the demand for poles, faggots, oak-bark, and hurdles has slackened and, in some districts, entirely ceased. Hop-poles are still used in Kent, but the supply is so great as to lower prices below what will yield a profit to the grower. Faggots, which twenty or thirty years ago brought 23s. to 26s. per 100, can only be sold now at 10s. or 12s., chiefly owing to wood ovens having been supplanted by steam ovens. The use of chemicals and foreign tanning material has reduced the price of oak-bark from £8 or £12 a ton to £3 or £4, which scarcely does more than pay for the labour of stripping and

carriage. Hurdles are still in request, but even in these the producer has to compete with the increasing use of wire-netting; and charcoal burners, who used to take large quantities of undergrowth, are now scarcely ever seen out of the Midlands. Another use for coppice was the supply of barrel-hoops for the northern fisheries; the Spanish chestnut coppice of Sussex, it is said, used to command a price of £30 or £40 an acre on an eight or ten years' rotation; but the chief supply of barrel-hoops now comes from the Continent.

Nor can the owners of coppice afford to wait for better markets, as may be done with timber trees. Underwood must be cut at the proper age, or it is spoilt, and the condition of some woodlands in the south, where the working plan requires 100 acres or more to be cut annually, is going from bad to worse. The annual cuttings on a large estate in Hampshire used to realise upwards of £600, whereas in 1907 they brought only £160 (*Quarterly Journal of Forestry*, No. 3, p. 221). Now these and similar coppice woods occupy good agricultural land of far superior quality to that usually given up for planting. It is sheer waste to allow it to continue in its present unremunerative state, for which it would be unreasonable to expect any remedy in the future. But it offers an excellent opportunity for starting high forest on a good working scheme. There is no alternative between that and clearing the land for agriculture or pasture. The middle course, too often adopted in order to avoid outlay, of allowing the coppice to grow on in the hope of rearing chosen poles into forest trees, is very unwise. Ancient stools, which have been cut for generations, are quite unfit to throw up sizable timber, and such stems as they do produce are very liable to be blown out when the dead part of the stool rots in the ground.

When the working plan has been settled, the first result probably will be that the owner of the woodland must find a market for the trees it is decided to clear. He will be guided by local circumstances whether to fell them himself or to offer them standing, and whether to sell them by private treaty, by tender, or by auction. He will bear in mind that, if he fells them himself before coming to terms with a buyer, he must take whatever price is offered to him subsequently, even should it be far below fair value, because the trees must be removed. Generally speaking, the most satisfactory arrangement is to sell the trees standing either by private treaty or by tender, and for the owner to fell them, the purchaser paying a proportionately higher price. But this can only be done where a considerable staff of woodmen is kept, and in small establishments the easiest course is to sell standing for the purchaser to fell.

Timber can be valued standing by an experienced man almost as accurately as after it has been felled. Size, quality, and facilities of transport are the chief factors in valuation. The last two are comparatively simple to the practical eye, but to calculate the cubic contents of the trees on an acre of land requires special training, and is rendered peculiarly difficult if the trees are of different ages and kinds, and irregularly scattered over the ground, as is so commonly the case in the mixed plantations of this country.

The method of measuring cubic contents of individual trees varies considerably in different parts of the United Kingdom. Further, there is an important difference in the continental and British practice in this matter. Continental measurements give the exact cubic contents of the tree, but in Great Britain and her colonies the system called "square of quarter-girth measurement" is universal, whereby 21½ per cent. is deducted

from the true cubic contents to allow for wastage in sawing, etc. Moreover, in the United Kingdom nothing is paid for "lop and top," which includes all stem and branches of less diameter than 6 inches without the bark, or, say, 20 inches in circumference.

Subject always to local custom, the surest way to obtain the contents of any tree according to British measurement is—(1) to take the girth at breast height, which should be fixed at 51 inches above the ground; (2) to measure the height from the ground at which the girth diminishes to 20 inches, or the diameter to 6 inches free of bark (in the case of conifers for pitwood, 10 inches girth or 3 inches diameter), thus ascertaining the "timber-height" of the tree. Add the two girth measurements together, divide the sum by 2, which gives the mean girth; multiply the timber-height into the square of mean quarter-girth. The result shows the cubic contents of the tree, less 21½ per cent.

In open woods of irregular growth, the application of this method must necessarily be uncertain, unless the area to be cleared is so small that every tree can be measured. But in a crop of wood grown in close forest it is sufficient to measure the cubic contents of sample trees in order to arrive at a knowledge of the average of the whole.

In Germany tree measurement has been simplified by the framing of "form-factors" drawn up to show the proportion borne by the true cubic contents of each kind of tree to a cylinder having the same height and basal area as the tree, the basal area being equal to the mean girth of "timber-height." In uniform crops in close forest it may be assumed that all trees having the same basal area are of approximately equal height and correspond to a similar form-factor. There are, however, very few woodlands in Britain at present where the application of a form-factor would be any guide to the actual contents of the different kinds of tree composing them.

[The best modern works on British forestry are Dr. W. Schlich's *Manual of Forestry*, of which the first three volumes were written by himself, dealing with—i. "The Principles of Silviculture"; ii. "Practical Silviculture"; iii. "Forest Management"; and the last two, by Professor W. R. Fisher, dealing with—iv. "Forest Protection"; v. "Forest Utilisation" (3rd edition, 1904): *English Estate Forestry*, by A. C. Forbes, 1904: *The Forester*, by Dr. John Nisbet, 2 vols., 1905. A great deal of useful information is conveyed in Messrs. Elwes and Henry's splendid work on *The Trees of Great Britain and Ireland*, whereof two out of five volumes have been published in 1906 and 1907. Students are also referred to the Report of the Departmental Committee on Forestry, 1903, and to the later numbers of the *Transactions* of the English and Scottish Arboriculture Societies, the former of which has significantly altered the title of its periodical to *The Journal of Forestry*.]

Foul in the Foot of Cattle.—This affection consists of an inflamed condition of the skin and other structures situated between the claws or digits, and in some places is known as "Loo." Usually it occurs as a single case amongst a number of animals, occasionally a considerable number may be affected at the same time, and though always rather serious to the patient, it becomes alarming when occurring under the last-named conditions. The disease sometimes depends on overgowth of the horn causing the skin between the claws to be stretched as the animal moves, and so allowing germs to enter the skin, in which they set up inflammation, which

is frequently followed by death of the soft structures and sometimes of the bones of the foot. It may also follow injuries to this part caused by sharp bodies as glass, existing in places walked over by cattle, and these wounds becoming contaminated with micro-organisms which happen to be plentiful in the situation. It is under such circumstances that we may meet with several cases in a herd. It has been regarded by some authorities as one manifestation of tuberculosis, but this view has not been substantiated, and cannot be accepted. In some of the severe cases the mischief is really necrosis or death of the part which exists as a "core" or "slough." The affected animal becomes intensely lame, and often refuses to walk. The skin between the claws is much swollen, and the claws are separated. After a while the skin bursts, discharges matter, and the core is observable. In some severe cases the temperature rises, the patient refuses food, and evinces much pain by groaning, etc. The disease more frequently occurs in the hind feet, though the fore are sometimes affected. Occasionally death occurs. The treatment embraces paring or sawing off of overgrown hoof horn if such is excessive, thorough cleansing of the part by bathing in warm water to which some antiseptic such as carbolic acid has been added, the application of poultices wetted with an antiseptic solution, and surgical removal of the core. After this latter is effected some healing ointment may be applied and the part securely bandaged. In serious cases the skill of the veterinary surgeon will be required, for to effect recovery it may be necessary to amputate the lower part of the limb, as the disease may continue to spread and affect the bones. The old practice of pulling a tar rope backwards and forwards between the claws is of a barbarous nature and liable to do serious damage, and, though occasionally it may have effected good by removing the dead parts, it cannot be recommended.

Founder.—*See* Laminitis.

Foxtail Grasses.—There are about twenty species of foxtail grasses, chiefly inhabitants of cold and temperate regions, and comprised in the genus *Alopecurus*. About five species are met with in Britain, three of them being of agricultural interest.

The inflorescences are compact, cylindical, spike-like panicles. The spikelets are one-flowered, compressed, with two empty glumes often slightly joined together near their bases. The flowering glume has a bent dorsal awn, and there is no palea.

The following three species deserve attention:—

1. Meadow Foxtail (*Alopecurus pratensis*, L.).—A well-known perennial species, frequent in all good pastures and meadows where the soil is stiff and damp. It grows to a height of 1 to 3 feet, and has short rhizomes below ground. The inflorescence is clothed with soft silky hairs.

Meadow foxtail is one of the earliest grasses, flowering in April and May, and is one of the best of the larger grasses for meadows and pastures. It is nutritious, and grows well after cutting. On account of its early growth, it is better adapted for grazing than for hay, since its leaves are often withered before the rest of the herbage is ready for cutting.

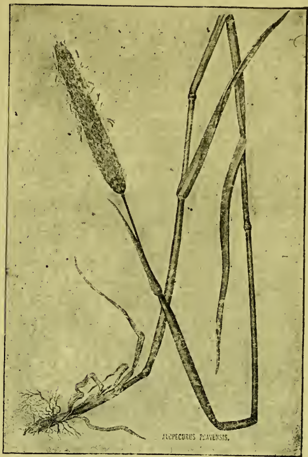
It develops too slowly for use in short leys, but should be a constituent of all permanent grass mixtures on the stiffer clays and loams. It is of no use on dry land, and money expended on its seed is thrown away on such land.

The commercial samples of seed are often of very poor germinating quality.

2. Slender Foxtail; Black Grass (*A. agrestis*, L.).—This is an annual grass, with longer, more slender inflorescences than meadow foxtail, and often of a dark greenish-purple colour. The spikelets are harsher and less hairy than those of the previous species.

It is one of the worst pests of arable land when once established, as its seeds after being shed germinate irregularly, coming up at intervals for several years.

Its seeds are sometimes met with as an impurity or adulterant in commercial samples of meadow foxtail seeds. They can be distinguished by their larger size and absence of hairs on the keel of the glumes.



Meadow Foxtail.

3. Floating Foxtail (*A. geniculatus*, L.) is a perennial grass with a decumbent stem which is bent at the joints. It grows around the edges of ponds and about wet places and ditches, especially on stiff land. Stock like it, but the produce is small.

Fracture of Bones.—There is abroad a very general impression that the broken bones of the lower animals do not become repaired as do those of man, and the lives of many very valuable animals have been sacrificed to the mistaken notion. It is, indeed, a popular fallacy, as the tendency for the union of the broken ends is equally great in both. The difference in the results of attempts to bring about union depends on the difficulty of controlling the movements of the lower animal. It is this difficulty of restraining movement, in association with the fact that lameness, which frequently remains after union, often detracts from the sale value and sometimes the usefulness of the animal, that has partly given rise to the idea that slaughter is the only course of action in all cases. In some cases, even in horses, a broken bone of a limb may join, without leaving lameness. It is, however, more important to realise this natural tendency to union and recovery from consideration of return to usefulness for breeding or fattening purposes.

Fractures are more commonly caused by some mechanical force of an extraordinary character, but concussion resulting from bringing too much weight of the body on to a limb is occasionally sufficient to break an animal's bones, and this is not infrequently the case in fracture of the horse's pastern bone; while in young animals in which the ends of the bones are not firmly united with the body or "shaft" of the bones, these may be torn asunder by violent muscular action, etc., as is observed with the elbow of young horses galloping in the field and suddenly pulling up. Some conditions of the bones themselves may predispose them to fracture. Such predisposition has been recorded as occurring amongst sheep in certain districts, where the material essential to bone formation is scant. It

undoubtedly exists in the bones of horses in some diseases. Cold weather is often regarded as rendering bones brittle and easily broken. If, however, it is more common to meet with fractures in cold weather, the cause probably is more closely related to the hardness of frozen matters with which bones are brought into contact, than with any change in the bones themselves, whose temperature is about the same in cold as in temperate weather. When a bone is broken and there is no wound admitting external air to the broken ends, the fracture is termed *Simple*. When air gains access through a wound to the broken ends, the fracture is *Compound*. The importance of fracture and the symptoms will vary with the bone fractured, and the amount of displacement of the broken ends. Some may be immediately fatal, as in cases of the base of the skull or the neck bones; others, as that of the point of the hip, causing little inconvenience. A broken rib may give rise to no appreciable symptoms, and only be discovered after death of the animal from natural causes; at other times the fractured ends may pierce the lungs and prove fatal.

The symptoms, of whatever kind, come on suddenly, and usually there is history of some accident. The bones of the limbs are more exposed to force and thus more liable to fracture. Sudden lameness is usually noticed. The part of which the bone is the support becomes more movable, a sensation of crackling or crepitation may be experienced on manipulation, and a soft swelling generally follows in a short time, the result of ruptured blood vessels, etc.; later the swelling becomes hard, a ferrule of bone—the external *callus*—is formed to keep the broken ends together while true healing of the bone proceeds. When union is accomplished, this hard swelling diminishes in size. The period of time necessary for union, and the extent of the permanent swelling, depend largely on the degree of displacement of the broken ends and the fixture of the parts. Firm union requires months. It sometimes takes nine or ten, and occasionally fractures do not unite at all. In some positions, for instance, that of the pastern of the horse, a common seat of fracture, there may be no appreciable displacement or movement, and comparatively little swelling.

The treatment of fracture consists of bringing the ends in apposition and keeping them so. The details are best carried out by the surgeon possessed of the necessary anatomical knowledge, manipulatory skill, and experience of appliances. The attendant of the animal may, however, do much before the arrival of the veterinary surgeon, by supporting the broken bone and preventing movement of the parts by applying temporary splints and bandages and keeping the animal quiet. It must always be borne in mind that the earlier the bone is skilfully set after fracture the greater the chances of perfect setting and recovery.

Freehold.—*See* Land Tenure, Systems of.

Free Marten.—This is the name given to a twin female (heifer) calf, born along with a male or bull calf, and in which the generative organs are imperfectly developed (hermaphrodite); such animals are unfruitful or non-breeders, and have no sexual desire. In some parts it is thought that if the heifer or female calf be born first it will be productive, but if the bull or male be first cast then the heifer will be sterile; the matter of breeding, however, all depends upon the development of the generative organs; if these be perfect and properly formed, the animal will breed as well as any

other. Animals of single birth have at times their generative organs so imperfectly developed that they are unfruitful; instances of which have been observed in both mares and cows. Cases are on record where the twin female or heifer has been very prolific, and in turn, like its own parent, produced twins. It is generally thought that these free mártens are more common in the bovine species than in any other, yet when it is taken into account the limited number of twin calves—male and female—that are born, it is more apparent than real. When a female twin or single turns out to be a hermaphrodite, its general form is more like that of a male than a female, while the generative organs are very imperfectly developed, having in most cases both male and female organs combined, and in some instances when micturating the urine instead of falling straight to the ground is ejected right up into the air. As such animals are of no use for stock purposes the sooner they are fed off the better.

Frit Fly.—*See* Corn and Grass Pests.

Frozen Meat Trade.—To have a reliable supply of food is a necessity for any country, but more especially is it the case in a country like Great Britain, where the population per acre of land is so large, and where the larger portion of the workers are engaged in industries separate from agriculture.

A population of 43,000,000 living on a surface area of 78,000,000 acres must have supplies of food from outside sources, and as the inhabitants of Great Britain are the largest meat consumers in the world, the question of supplying the demand is one of world-wide importance.

The demand up to about 1880 was supplied by the importation of live animals, which were usually finished in the fattening process on British pastures, after an ocean voyage, before passing through the slaughter-houses and butchers' shops on their way to satisfy the flesh-eating propensities of the British public. The system, however, had many drawbacks, as many cattle died in transit, and the quality of the meat was so affected by long travelling in railway waggons and in the badly arranged holds of cattle ships, that a severe strain was often felt by the importers, and much money was lost in carrying on the business.

The prejudice in favour of having the animal imported alive, so that the butcher could satisfy himself that the meat was in healthy condition, was very strong, and the idea of killing the animal abroad and importing, by one means or another, the prepared beef or mutton, only took root very slowly. One reason for this was that the principal supplies came from the United States of America, and the distance seemed to be so small that it outweighed any humanitarian or other considerations, and therefore imports of live stock bulked largely in the general returns.

The consumer of meat had also a good deal to say in the matter, as it was a deeply rooted conviction in most minds that produce other than home-grown was inferior, and with true British conservatism the prejudice was handed on when the frozen meat trade began. It was then argued that not only was inferior meat sent into the country, but the very process of preserving by refrigeration reduced the nutrient value of the product. These prejudices have been gradually dying out, and since 1880, when the first frozen meat imports took place, the popularity of frozen products has steadily gained ground, at least in the manufacturing centres of the United

Kingdom. The growth of supplies has steadily risen from 72,553 tons in 1890 to 308,059 in 1906, while chilled meat has also made steady progress, and in the latter year amounted to 159,387 tons; both together being something like a third of the total estimated available supply of beef, mutton, and lamb in the United Kingdom.

The initial difficulties of shipment were great, but were perseveringly overcome; the use of refrigeration going a long way in solving the difficulties.

It is interesting to recall the fact that the chilling of food for transit is a very old system, as the Romans used to transport their oysters to the inland towns by packing them in closely compressed snow surrounded with straw and rolled up in a woollen cloth. In less ancient times ships carried the meat slung up to the yard-arm so as to keep it, and no doubt the influence of the salt from the sea and the absolutely healthy surroundings were splendid antiseptics. Large quantities of meat, however, could not be carried in this way, and mechanical appliances had to be introduced to make a large trade possible.

It is outside our scope here to discuss the various inventions which were the forerunners of and went to build up our modern refrigerating machines, but Jacob Perkins' invention of his ether machine in 1834 may be said to be the first stage in making an oversea trade in meat possible; the inventions of the Frenchman Carré, Harrison of Geelong, Australia, Twining of Ohio, U.S.A., Nicolle of New South Wales, Mort of New South Wales, also formed links in the chain. The pioneers of the idea were, of course, the great chemists Lavoisier and Faraday, and it is to the latter that Mort's application of 1867 referred when he specified his patent as "an application of Faraday's discovery of the liquefaction of certain gases by pressure, and the capacity of such gases for the absorption of heat on their release from liquefaction," and went on to put in his claim "specially for the use of ammonia gas being more suitable for shipboard."

In 1877, Mort invited a large number of gentlemen to his works at Lithgow, on the Blue Mountains of New South Wales, to sample refrigerated beef and mutton eighteen months old; and it was at the banquet then given that Mort, in his speech said, "It was my friend, Mr. Augustus Morris, who first suggested the diabolical method of freezing meat to send to England, and he it was who introduced me to Mr. Nicolle; and I will tell you that it is not once nor ten thousand times I have wished that Mr. Nicolle, Mr. Morris, and myself had never been born."

In a brilliant peroration Mort declared that "Faraday's magic wand gave the keynote, and invention has done the rest. Where the food is, the people are not; and where the people are, the food is not; but climate, seasons, plenty, scarcity, distance will all shake hands, and out of the commingling will come enough for all."

In Scotland two brains had also been at work on the subject, and in 1879 Messrs. Bell and Coleman of Glasgow fitted out the *Strathleven* with mechanical appliances, and successfully carried a cargo of meat from Australia to London. The trade thus begun soon grew to large dimensions, and the 400 carcasses which reached London in 1880 from Australia has steadily gone up, until in 1906 no fewer than 1,732,328 carcasses were shipped to the United Kingdom from the same source. New Zealand shipments began in 1882 with 8839 carcasses, and in 1906 the shipments amounted to 4,148,288 carcasses. The shipment of frozen meat from Argentina to the United Kingdom has also shown an expanding record, for against 17,165 carcasses shipped in 1883, when the trade commenced, the

total in 1905 amounted to 3,203,210 carcasses. It is interesting in this connection to record the opinion of the United States Consul-General at Buenos Ayres, who at the end of the year 1904 wrote:

"When it is realised that the United States, with 44,000,000 horned cattle, 41,800,000 sheep, and 57,000,000 hogs, can, after providing food for a population of 80,000,000 inhabitants, export meat to the value of 240,000,000 dollars; Canada, with 4,000,000 cattle, 4,000,000 sheep, and 5,000,000 inhabitants, can export 25,000,000 dollars worth of meat; and Australia and New Zealand, with 10,000,000 cattle, 80,000,000 sheep, and 5,000,000 inhabitants, have meat exports to the value of 33,000,000 dollars, it can be understood that Argentina, with 28,000,000 cattle, 110,000,000 sheep, and a population only equal to that of Australia (5,000,000), is backward in these industries in exporting to the amount of only 15,000,000 dollars annually (previous to 1903). Furthermore, Argentina has sufficient territory for feeding 100,000,000 horned cattle and 300,000,000 sheep, while its wealth in these animals might be quintupled by merely improving their quality and by raising them with more care, for it costs as much to keep an ordinary animal as one of pure breed. In 1903 the value of the meat exported from Argentina had already increased to 20,000,000 dollars. Frozen mutton had increased from 2,722,000 carcasses in 1902 to 3,429,000, and frozen beef from 124,000 to 207,000. In the first quarter of 1904 the exports of live stock and of meat frozen, salted, etc., amounted in value to 6,000,000 dollars, or 3,000,000 dollars more than in the corresponding period of the year 1902. The rate of exports may therefore easily reach 30,000,000 dollars by the end of this year. The closing of the ports on account of epidemics can no longer be a danger for the Argentine pastoral industry. The freezers have settled this question, and perhaps in a more advantageous manner economically, considering that less is expended in freights, that only the carcasses are exported, and that the animal remains can, with advantage to the country, be transformed for subsequent exportation."

The United States are large shippers of frozen beef, although their shipments of mutton are infinitesimal compared with the Australian and New Zealand Colonies. The totals of all classes of beef and mutton imported into the United Kingdom, with the places of origin for 1906, are as follow:

	Mutton. Cwt.	Beef. Cwt.
South America . . .	1,473,239	2,814,622
United States . . .	2,670	2,426,644
New Zealand . . .	1,748,188	236,587
New South Wales and Victoria . . .	606,614	19,904
Queensland . . .	10,256	18,812
Canada	...	8,415
Holland	234,926	2,858
Germany . . .	...	1,116
Other places . . .	12,796	171
Total .	4,088,689	5,529,129

As an instance of the immense amount of money invested in the carrying of frozen and chilled produce, it may be mentioned that nearly every steamer that touches the principal Atlantic ports is equipped for carrying meat, and this means that every ship has an expensive installation of refrigerating machinery and insulated chambers in the holds. In the

Australian, New Zealand, and River Plate trade, there are something like 180 steamers equipped for carrying frozen meat, and taking their capacity as for carcasses of mutton, the combined available capacity works out at over 12,000,000 carcasses. At all the principal ports in the United Kingdom cold storage exists for handling and keeping the carcasses after they are landed, and the capacity of these may be gauged by taking London as an example, with its twenty-seven cold stores specially dealing with frozen meat, having a combined capacity of nearly 3,000,000 carcasses of mutton.

It will be readily understood that in the process of manipulating sheep from our Colonies and cattle from the American prairies, converting them into meat and distributing the product at centres thousands of miles from the place of origin, requires a very complete system. It is practically the same system in each case, and it always begins on the ranche. When animals are meant for the export trade they are specially selected, as nothing but the finest quality will pay to send to the United Kingdom. The inspection which is carried out both in the Colonies and America is very stringent, as the reputation of the exporting country always suffers if anything of an inferior quality is allowed to pass. In Chicago a definite classification is applied to all cattle that reach the stock yards, "Beef Cattle" being the highest grades; this classification includes cattle meant for the chilled or frozen trade. The other classes are:

Texas and Western Range cattle,
Butcher stock,
Cutters and canners,
Stockers and feeders,
Veal calves.

Under the head of "Beef Cattle" are quoted all grades of fat steers and heifers that have received sufficient food to show that a fairly successful attempt has been made to fatten them. This class includes everything from prime steers to the common rough grade of steers. It includes everything from the heaviest shipping steers to the lightest grades of dressed beef, export and shipping steers.

It is condition and quality rather than weight that decide whether a steer or heifer would be included in the "Beef Cattle" classification. Thus we can understand how an 800 lb. yearling possessing quality and finish might more consistently fall under this head than a heavier, plainer steer lacking either quality or condition, or both. Fat steers and heifers are in demand in the Chicago market by three classes of buyers, namely, exporters for the British market, packers for dressed beef slaughtered in Chicago, and Eastern buyers to ship for slaughter to Boston, New York, Philadelphia, Pittsburg, Baltimore, Cleveland, Albany, Detroit, and many smaller cities.

The following grades include the bulk of shipments that would be classed as beef cattle:—

Prime steers	1200 to 1600 lb.
Choice steers	1150 „ 1600 „
Good steers	1150 „ 1600 „
Medium steers	1100 „ 1400 „
Common rough steers . . .	900 „ 1200 „

The terms *prime, choice, good, medium,* and *common* refer to the quality

and condition of cattle in the market, all or part of which may properly be used to indicate grades within any class of cattle.

Prime steers.—When the word prime is used to designate the quality and condition of cattle, it is understood to be the very best grade of the class, unless possibly a few fancy cattle of showyard merit that occasionally reach the market are excepted. Prime steers are taken largely by buyers for the Eastern markets and by packers for the dressed beef trade, the former taking the bulk of such cattle. Such steers are practically above criticism both as to quality and condition.

The packing house proprietors discourage excessive driving of animals meant for slaughter, for animals suffering from mental or physical excitement are not fit for killing. Drovers are warned against beating or otherwise subjecting the animals to ill-usage, and to make sure that everything is right, twenty-four hours' rest is generally allowed the animals before they are driven to the slaughtering pens. A rigid system of inspection by Government officials is carried out both with the live animals and also afterwards with the dead carcasses, and nothing but first-class quality is allowed to get into the market for human consumption. The cattle are driven to the pens on the top of the building, rested, and then made to walk single file along narrow gangways to the killing pen. The operator from an elevated position and with unerring aim fells them with his pole-axe, unconsciousness being practically instantaneous. As the animal collapses, it automatically releases a trap-door, which allows the carcass to fall to the floor below, where the bleeding takes place. The trap-door immediately swings back ready for the next comer, and the killing proceeds at the rate of about eight per minute. On the bleeding floor the carcasses are hitched to running tackle by the hoofs and carried along the bar, where men cut through the large arteries of the neck and let the blood flow; about two minutes is allowed for each carcass to drain. The next stage is the dressing-room, where a squad of men each do their part in cutting down, removing the tail, and so on; the skins and entrails are removed within a few minutes, and the sides are washed down. A stalwart Hercules with two blows of a cleaver cuts the backbone lengthwise, after which the sides are weighed and inspected. If no fault is found, the sides are then taken to the chill-rooms, where a temperature of 34 to 35 degrees Fahr. prevails. Wheel-travelling hooks are used for transporting the sides along the track bars, and switches are so arranged that a side can travel from end to end of the system without having to be lifted off. The Government tag is affixed in the chill-room, and after hanging for forty-eight hours the sides are taken for transit to the refrigerator cars. From the time the operator strikes the blow that finishes the animal's existence until the carcass, in the shape of sides of beef, reaches the chill room, about three-quarters of an hour elapse. Export sides are always sewn up in white sheets, and great care is taken to ensure a constant temperature on board ship. The temperature maintained during the voyage is 30 to 32 degrees Fahr., and it is usual to embed a self-registering thermometer in the cargo so as to check variations in temperature.

The Colonial Government and the Government of Argentina are also very strict in their system of inspection, and carefully guard the reputation of their respective countries, so that it may be taken for granted that nothing but the finest quality of beef and mutton come into the frozen trade.

The shipping companies have a great responsibility in the matter, and indeed the link they form in the chain of transport is the most important

of all. The delivery of a frozen cargo in good condition depends so much on the skill and care of the engineer on board the steamer, that if he is careless the finest mechanical appliances will not prevent disaster. Many of the companies give a bonus to their engineer on cargoes that are delivered in good condition, but very often considerable damage is occasioned by the difficulties of loading the cargo owing to hot winds and unequal temperatures in the holds. There is also a source of occasional damage in unloading into barges at London and other ports, as there are no refrigerating appliances on board the barges, and they may often be afloat between the ship and the cold store for a couple of days.

The question of the loss of weight on meat kept in cold stores is one that often comes up, and there is no doubt that the question is a real one. The process of freezing helps to retain a considerable amount of moisture in the carcass, and it is obvious that where meat is kept in the cold store at or about freezing-point, with the surrounding air comparatively dry, a loss of moisture is almost bound to take place, and there will consequently be a diminution in weight in proportion to the humidity of the atmosphere in the store. Mr. Heugsto, in his experiments in German slaughter-houses, found that when the temperature of the store ranged between 36 degrees and 40 degrees Fahr. a loss as high as 4 lb. 6 oz. took place on legs of beef, while a loss of 18 oz. took place on legs of veal and pork, and 4½ oz. on legs of mutton in a week.

Mr. Schwartz found that a piece of beef weighing 116 oz. lost 29 oz. in twenty-two days, seventeen days later 12 oz., twenty-eight days later 9 oz., that is a total of 50 oz. in sixty-seven days, or 43 per cent. Another piece of beef weighing 200 oz. lost 51 oz. in fifteen days, and 11 oz. more in another twenty-five days, or 62 oz. in forty days, or 31 per cent. At Goltz an experiment was made at a temperature of 40 degrees Fahr. for eight days, with the result that ¼ bullock weighing 156 lb. lost 8 lb., ½ pig of 98 lb. lost 3¼ lb., a calf of 83 lb. lost 8 lb., and a sheep of 78 lb. lost 3¼ lb. Further, a quarter of beef weighing 191 lb. after hanging for four days in a warm dry temperature of 77 degrees to 88 degrees Fahr. lost 13 lb.

Reference has been made to the prejudice against frozen meat on the grounds of quality, but the experiments, both analytical and microscopical, of Dr. Rideal, the well-known London analyst in 1896, and again in 1907, seem to prove that weight for weight, the food value of frozen and chilled meat is equal to that of fresh-killed. This will no doubt be controverted by British farmers and stock breeders, but the experiments were very exhaustive and included—analysis in the ordinary way, comparison as to value in making soups and gravies, comparative value of extracts and comparative digestibility. Dr. Rideal's conclusions were that "both with regard to digestibility and for the preparation of soups or beef-tea, the hard frozen meat was intrinsically the same value as that which had been chilled for a short period or freshly killed." He also found that no incipient decomposition or hydrolysis takes place under cold storage.

Fruit and Fruit Trees, the Insect and Mite Enemies of.

Apple.

The Apple Blossom Weevil (*Anthonomus pomorum*).—This beetle is the cause of much loss in the fruit crop. The beetle is very small, measureing only ¼ inch in length; it is black, with an ash-grey pubescence; a little

Plant.	Order of Pest.	Name of Pest.	Stage in which the Pest is harmful.	Part of Plant attacked.
Apple	Coleoptera	Apple Blossom Weevil	Grub	Blossom
	,,	Garden Chafer	Adult beetle	Leaves and young fruit
	Lepidoptera	Wood Leopard Moth	Caterpillar	Stem & branches
	,,	Goat Moth	,,	,,
	,,	Small Ermine Moths	,,	Leaves
	,,	Pith Moth	,,	Shoots and buds
	,,	Codling Moth	,,	Fruit
	Hymenoptera	Apple Sawfly	,,	,,
	Hemiptera	Woolly Aphis	All stages	Stem, branches, roots
	,,	Apple Leaf Aphis	,,	Leaves & blossom
	,,	Permanent Apple Aphis	,,	Leaves and young shoots
	,,	Rosy Apple Aphis	,,	Leaves
	,,	Mussel Scale	,,	Stem & branches
	,,	Oyster Shell Bark Scale	,,	,,
	,,	Apple Sucker	,,	Leaves and blossom buds
Pear	Coleoptera	Leaf Weevils	Adult	Buds and leaves
	Lepidoptera	Vapourer Moth	Caterpillar	Leaves
	Hymenoptera	Social Pear Sawfly	Grub	,,
	Diptera	Pear Midge	Maggot	Young fruit
	Acarina	Pear-leaf Blister Mite	All stages	Leaves and young fruits
Plum	Coleoptera	"Shot-borer"	Adult	Stem & branches
	,,	Fruit-tree Bark Beetle	Adult and grub	,,
	Lepidoptera	Winter Moth	Caterpillar	Leaves
	,,	March Moth	,,	,,
	,,	Mottled Umber	,,	,,
	Hemiptera	Plum Aphis	Various stages	Leaves & blossom
	,,	Mealy Plum Aphis	,,	Leaves
Cherry	Hymenoptera	Cherry and Pear Sawfly	Caterpillar	,,
	Hemiptera	Cherry Aphis or Black Fly	Various stages	Young shoot and leaf and fruit
Raspberry	Coleoptera	Otiorrhynchus Weevils	Grub and adult	Roots, buds, shoots, leaves
	,,	Raspberry Beetle	Adult and grub	Flower buds and blossom
		,,		fruit
	Lepidoptera	Raspberry Moth	Caterpillar	Bud and shoot
Strawberry	Coleoptera	Ground Beetles	Adult	Fruit
	,,	Otiorrhynchus	Adult and grub	Shoots & runners roots & crowns
Currant	Lepidoptera	Shoot and Fruit Moth	Caterpillar	Fruit, bud, shoot
	,,	Clear-wing Moth	,,	Shoots
	Hemiptera	Currant Aphis	Various stages	Leaves
	,,	Currant Blister Aphis	,,	Leaves
	,,	White Woolly Scale	,,	Shoots
	Acarina	Currant Gall Mite	,,	Buds
Goosebery	Lepidoptera	Magpie Moth	Caterpillar	Leaves
	Hymenoptera	Gooseberry and Currant Sawfly	,,	Leaves and berries
	Hemiptera	Brown Gooseberry and Currant Scale	Various	Branches
	Acarina	Gooseberry Red Spider	Various stages	Leaves

behind the middle of the wing-covers is a pale band, shaped like a very open V. A curved snout is present half as long as the body.

The larva is a legless grub, yellowish-white in colour, and with a brown horny head; the body is wrinkled and measures $\frac{1}{3}$ of an inch.

The pupa is pale yellow, and shows the snout and the legs lying along the under surface of the body.

The beetle issues in spring from its winter quarters, and after making a hole in the flower bud introduces an egg, proceeds to another flower bud, punctures it and lays another egg, and so on. The grubs on hatching remain in the blossom, which as a result later on looks brown or rust-coloured, as if the blossom had been frosted. Pupation takes place in the spoiled blossom, and the beetle when ripe bores through the blossom to the open. The adult beetles pass the winter under cover of bark scales and other shelter places.

Treatment.—Spray in February with the Woburn emulsion soda wash, recommended by Mr. Spencer Pickering, namely, sulphate of iron, $\frac{1}{2}$ lb.; lime, $\frac{1}{4}$ lb.; caustic soda, 2 lb.; paraffin, 5 pints; water to make 10 gallons. Dissolve the iron sulphate in about 9 gallons of water. Slake the lime in a little water, and then add a little more water to make it into a milk. Run the lime water into the iron-sulphate solution through a piece of coarse sacking to keep back grit. Churn the paraffin into the mixture. Add the caustic soda in a powdered condition just before using. The above can be procured made from Voss & Co., Glengall Road, Millwall, London. A gallon of the emulsion together with the soda costs 1s. 3d. The wash is a burning one, and the face and hands must be protected against it. The wash in the spraying machine should not be exposed to the air.

Clear any rubbish, long grass, leaves, from below the trees.

Shake down attacked and infested blossom, and collect and burn so as to destroy the enclosed larvæ or pupæ.

THE GARDEN CHAFER OR SMALLER JUNE BUG (*Phyllopertha horticola*).—The beetles are found flying about in June and July, in some years in perfect swarms.

The beetle is about $\frac{1}{3}$ of an inch long. The colour is shining greenish-black, with blackish or grey hairs. The head and thorax are glossy blue-green. The wing-covers are generally yellow-brown, sometimes darker at the edges.

The harm done is in the adult stage, the beetles eating the leaves and gnawing pieces out of the young apples.

The beetles should be shaken off the plants on which they collect on to cloths spread for the purpose. This should be done in the early morning when the beetles are sluggish.

The eggs of the beetle are laid in garden soil and in grass land.

THE WOOD LEOPARD MOTH (*Zeuzera aesculi*).—The caterpillars of this moth feed inside the stems and branches of apple, pear, cherry, as well as in those of a number of forest trees. Branches of apple are sometimes quite spoiled by the caterpillar galleries.

The moth is a large one with a wing-spread of 2 to 3 inches. Front wings white, with numerous black-blue spots. The hind wings are similarly spotted, but the spots are fainter. The thorax is white with three pairs of large dark dots. The caterpillar measures up to 2 inches when full grown. It is yellow-white in colour, spotted with black; the head is dark and on the first segment behind the head and on the last one is a black plate.

The moth lays its eggs in June and July, and the caterpillar may have a life of two years. Pupation takes place in the tunnelled shoot.

Treatment.—Cut off and burn infested branches.

A larger caterpillar, that of the Goat Moth (*Cossus ligniperda*), may also be found tunnelling the stems of apple and other fruit trees. The grown caterpillar is red on the upper surface and yellowish on the under surface; the head is black, and there is a dark shield on the next segment.

The Small Ermine Moths (*Hyponomeuta*).—The moths are small, with slate-coloured or light grey fore wings dotted with black; the hind wings are darker and have long fringes.

The caterpillars are social, living a number together, in gauze-like webs or nests. The pupæ are also enclosed in the web. *Hyponomeuta padella* lays its eggs on apple, medlar, plum, and other rosaceous trees. The caterpillars of *H. malinella* feed on apple trees.

The moths fly in July and August, when the eggs are laid. The caterpillars do their damage in the next year, feeding, it may be, at first inside bud and leaf, but, later, externally on the leaves, so that trees may be quite stripped.

Treatment.—Cut off infested twigs and crush or burn the webs with the enclosed brood. Spray with paraffin emulsion before the webs have become large and thick.

The Pith Moth.—The pith moth is found from Lancashire southwards. Its caterpillars bore into terminal and other shoots and buds of young apple, and the fruit spurs are specially harmed. From the presence of the caterpillar, buds do not burst, shoots wither, and the leaves flag. The caterpillar is very small and brownish in colour; it is full grown about the end of June.

Treatment.—Pick and burn attacked shoots and spurs in the spring. Winter pruning.

The Codling Moth (*Carpocapsa pomonella*).—The moth is $\frac{1}{3}$ inch long and barely $\frac{3}{4}$ inch in spread of wing. Front wings grey with wavy brown lines; towards the outer edge of each fore wing is an oval yellow patch. Hind wings darker. The moth rests during the day and flies at night. The caterpillar when full grown measures nearly $\frac{3}{4}$ of an inch, when it is flesh-coloured with a brown head; it has sixteen legs.

The moths issue about the end of May; the females after pairing lay their eggs on the outside of the very young apple, typically only one egg to each young apple. The caterpillar on hatching makes its way to the calyx end of the apple, and enters there, after feeding it may be for a short time just within the calyx. A tunnel is made into the fruit, and in time the centre is reached, waste matter being pushed to the outside. When full grown—in from three weeks to a month—the caterpillar bores out of the apple and lets itself to the ground, or crawls down the stem. The caterpillars on reaching the ground make for some sheltered place below, or reascend the tree and find on it some sheltering place in crack or under bark, etc. In the chosen place a cocoon is spun, and in due course pupation takes place. There is some proof that there can be two generations in the year in Britain.

Treatment.—Spray the plants with Swift's arseniate of lead; or with Paris Green—1 lb. of Blundell's Paris Green to 200 gallons of water. This spraying should be done, if possible, not later than a week after the blossom has fallen. The point of importance is that the lobes of the calyx should be somewhat open, so that the poison in the spray shall reach, and lie in, the cavity at the calyx, in which case the young caterpillar on eating here, will be poisoned before gaining entry to the fruit. If the spraying be delayed, the sprayed material, on account of the closing of the remaining flower parts, cannot reach the proper place.

Trapping caterpillars and cocoons. In May bands of hay or sacking should be placed round the trees not far from the bottom. Caterpillars

in crawling up the trees use these bands as shelter places; the trapped caterpillars, or later the cocoons, should be destroyed.

Rubbish or material below the trees that could serve as shelter places should be cleared away. Barrels and boxes in which apples have been conveyed may contain caterpillars or cocoons, and so serve as sources of infection. Apple-rooms should also be attended to. Treat the trees in winter with the emulsion soda wash recommended under Apple Blossom Weevil.

THE APPLE SAWFLY (*Hoplocampa testudinea*).—This sawfly is reddish-yellow in colour, with the top of the head, the body between the wings, and the upper surface of the abdomen brown-black or black. The wings are clear like glass with the veins at the base dark. It is $\frac{1}{4}$ of an inch long. The caterpillar is cream-coloured, and has twenty legs.

The sawflies issue from their cocoons from the middle of May onwards. The females lay their eggs below the calyx, and the caterpillars feed in the young fruit, hollowing out the apples until these fall away. The full-grown caterpillar falls with the destroyed fruit, or drops from it and passes in June and July into the soil, where a cocoon is made, the adults coming away in the next season.

Treatment.—Pick and burn infested fruit, or when the plants are high, shake the infested apples down; collect these and burn. This should be done at regular intervals.

THE WOOLLY APHIS OR APPLE ROOT LOUSE (*Schizoneura lanigera*).—This insect is readily recognisable in an orchard by the white woolly material formed by the larvæ and females situated in the bark crevices. The white material is an excretion from glands in the back of the insect. Various forms of the woolly aphis are found in the course of the year's cycle, *e.g.*, wingless viviparous females, winged viviparous females, wingless males, wingless egg-laying females. The number of sexual individuals seems to be small; and it is from viviparous females hibernating under cover of crevice and moss and lichen that the next year's generations chiefly begin.

Infestation may be on the main trunk, or on the branches, or on the roots; in overwhelming attack the leaves are also infested. The fact that the woolly aphis lives below ground on the roots should be carefully noted, as the above-ground parts, though cleared of the insect by treatment, may, unless treatment has been extended to the root-infesting individuals, receive a new infection by individuals migrating from below.

Not only is the tree weakened owing to sap being drained away by the proboscides of the insects, but swellings result which crack and produce an appearance resembling canker.

Treatment.—To destroy the hibernating insects and collections of moss and lichen, use emulsion soda wash (*see* Apple Blossom Weevil). The wash should be applied thoroughly.

For destruction of the insect in the summertime there should be a thorough treatment with soft soap and quassia, or, better, with paraffin emulsion.

Against the root-infesting form bisulphide of carbon (its fumes are poisonous) should be used. The bisulphide of carbon is injected into the soil in four places about 2 feet away from the trunk. For each injection a fluid ounce of bisulphide of carbon would be sufficient for a large tree. The bisulphide of carbon when injected must not, as liquid, be allowed to touch the roots of the tree.

All nursery stock before being sent out should be fumigated.

THE APPLE LEAF APHIS (*Aphis fitchii*), THE PERMANENT APPLE APHIS

(*A. pomi*), The Rosy Apple Aphis (*A. sorbi*).—In these three aphides the winter is passed in the egg stage. The eggs hatch in April. In the case of *A. fitchii* the aphides from the eggs attack leaf and blossom buds. The blossom as a result becomes brown and dead. The attack on the leaf is not accompanied by a curling of the leaf.

In the month of June *A. fitchii* migrates probably to grasses, a later generation returning about the middle of September to lay eggs on the apple.

A. pomi.—The aphides from the eggs, and the later progeny feed on the underside of the apple leaves, and a marked curling of leaf follows. Young shoots may also be punctured but the blossom is not attacked. Winged forms in the summer spread infestation to other apple trees.

In autumn males and females are found, and after pairing, eggs are laid on the shoots and at the bases of buds.

A. sorbi.—This is a leaf-infesting species; the leaves, as a result of the proboscid punctures, curl. After several broods on the apple there is a migration to some other plant. There is a return in autumn when males and females appear. The eggs of this sexual generation are laid on the trunk, in leaf axils, and on spurs.

Treatment.—Spray with paraffin emulsion in the autumn so as to reach and destroy the generation that gives rise to the eggs from which, in the next April, the individuals of a new cycle would come. *A. fitchii*, as it does not cause a curling of the leaves, can also be reached by a spray in April, after hatching.

The Apple Mussel Scale (*Mytilaspis pomorum*).—This pest is found chiefly on apple, but it infests also pear, cherry, plum, and hawthorn. The female scale, which is the one generally observed, measures about $\frac{1}{8}$ inch long; round behind, the scale tapers to a point at the front end. The eggs are laid under the scale by the anchored female; as many as eighty can be laid by a single insect. From the eggs come active six-legged young, which crawl away from below the scale and are distributed by birds and insects and wind. They fix themselves to the plant by a proboscis and drain away the sap. This larva develops generally into a female, a sedentary form living below the excreted scale, anchored by a long proboscis sunk in the tissues of the plant.

Treatment.—The trunks should be kept free from encrusting moss and lichen by washing in winter with the emulsion soda wash (*see* Apple Blossom Weevil). This wash also kills the scales and their eggs.

As a certain number of the scales will escape the treatment, the young scales on hatching from the eggs that escape should be subjected, about the middle of June, to a spray of paraffin emulsion.

Young stock before or after planting should be fumigated.

The Oyster-Shell Bark Scale (*Aspidiotus ostreæformis*).—This scale is found on apple and other rosaceous fruit trees. The female scale or shield varies considerably in shape. Typically it is round and smooth, and not much raised. The centre of the scale is dark, the outer parts yellow-brown or dark grey. In diameter this scale may be over 2 millimetres. Below the scale lies the flat, round, yellow-coloured female with sucking mouth apparatus. The male scales are oval, and measure only 1 millimetre.

Fertilisation of the females takes place in May. From the eggs which are laid, larvæ hatch which wander over the bark and then fix themselves. The winter is passed in immature non-adult condition, the adult condition being attained in the next May.

Treatment.—Infested plants should, if the plants be dirty, be treated with the emulsion soda wash (*see* Apple Blossom Weevil), but if the scales can be reached, paraffin emulsion alone would be sufficient to kill them.

THE APPLE SUCKER (*Psylla mali*).—The adult insects, yellow-green in colour, can both leap and fly. They are very small, measuring only $\frac{1}{12}$ inch or a little more. They lay their eggs in the autumn on the epidermis and in cracks in the bark. The eggs do not hatch till the next April, when flat yellow-brown larvæ with red eyes issue and enter blossom and leaf buds. The blossom and leaves are spoiled by the sucking mouth parts of the insect draining away the sap. A dirty, sticky fluid is given off by the larva. The larva moults several times before the adult stage is attained, this stage being reached in May.

Treatment.—Spray in winter with emulsion soda wash (*see* Apple Blossom Weevil).

Spray, when the young are exposed in April, with dilute paraffin emulsion.

PEAR.

LEAF WEEVILS (*Phyllobius*).—*Phyllobius* is a genus of weevils characterised by a short, stout proboscis, and rather long antennæ; the first two joints of the antennæ are elongated, the other joints conical. The weevils are winged. Some are dull in colour with a grey pubescence, while others are bright green. Weevils of this genus are found now and again in great numbers feeding on the leaves of pear, apple, cherry, plum, apricot, peach. The soft parts of the leaf are destroyed, the veins being left.

Treatment.—Spraying the plants with Paris Green would result in the feeding beetles being poisoned. Shake the beetles down from the food plants on to tarred sacks spread below; this should be done preferably in the morning.

VAPOURER MOTH (*Orgyia antiqua*).—The caterpillars of this moth are destructive to the leaves of pear, apple, plum, hawthorn, rose, and other trees. The male moth is brownish in colour, with darker markings on the fore wings; near the hind angle of each fore wing is a white patch. The female moth has the wings abortive, so that she cannot fly; the female is grey in colour. The caterpillars may reach almost to 2 inches when grown; they are greyish in colour with red warts; very characteristic are the tufts of yellow-brown hairs on the back, and the bunches of dark hairs projecting from various regions of the body. The cocoon is yellow-grey, and is attached to leaf or twig or in bark crevice.

The female on issuing from the cocoon settles on the outside of it, and there, after pairing, lays a collection of eggs. The eggs hatch into the caterpillars, which swarm over the tree. From the overlapping of generations caterpillars may be found from May till September.

Treatment.—Destroy cocoons and egg-masses in winter. Spray the plants—but not near the time when the fruit will be harvested—with Paris Green or Swift's arseniate of lead.

SOCIAL PEAR SAWFLY (*Pamphilus flaviventris*).—The larvæ of this insect are occasionally troublesome in England on pear; they are also found on plum, cherry, and other rosaceous plants. The female sawflies, in summer, lay their eggs in rows on the underside of the leaves. The grub is smooth, and orange or orange-red in colour, with the head shining black; it may reach, when full grown, to an inch in length, but there are only three pairs of legs; two little processes project at the hind end. The

grubs live socially in a web spun by them; this web is added to as required, and from it the grubs project to feed on the leaves. When full grown the grubs let themselves to the ground, and pass into the soil, where they pupate.

Treatment.—Cut away the nests, allowing them to drop into a pail containing some paraffin.

PEAR MIDGE (*Diplosis pyrivora*).—This two-winged fly appears in April, and lays its eggs in the buds or inside the blossom; if the flower bud be unexpanded, the midge punctures it by means of its ovipositor. The eggs are laid in little clusters, hence a number of maggots are found in one fruit. The maggots are yellowish-white with brown heads; they are legless; on the underside at the head-end is a characteristic anchor process. When full grown, the maggots may measure $\frac{1}{6}$ inch in length. The maggots show, on removal from the fruit, a skipping movement.

When the maggots hatch from the eggs they eat into the young fruit, tunnelling to the centre, and destroying the flesh. The fruits: the infested fruits become distorted, and are quite ruined. When the maggots are full grown they drop from the pears, or they fall with the pears and then leave them, passing in both cases into the soil, where, after a time, they become pupæ, the flies issuing in the next April.

Treatment.—Where the trees are small hand-pick and burn the infested fruit. There should be concerted action, however, in treatment; midges from untreated gardens or orchards may set up infestation anew. Wherever possible the surface soil should be worked, and the pupæ buried so deeply that issue of the fly is impossible.

Spring frosts by destroying the pear blossom, and therefore the food of the maggots, are nature's check on overwhelming numbers.

PEAR-LEAF BLISTER MITE (*Eriophyes pyri*).—This is an extremely minute mite which requires magnification under the microscope before structural details can be observed. Magnified, the mite is seen to have a narrow roundish body, distinctly ringed. At the front end is the rostrum and four legs. The mites pass the winter under cover of the outer scales of the buds, and in spring attack the young leaves so that blisters show. At first the blisters are red or green, but later they are brown. Badly blistered leaves are unable to perform their function. The mites may also be found under the skin of the young fruits. Before leaf-fall the mites pass to the buds for hibernation.

Treatment.—Pick and burn galled leaves by July.

PLUM.

SHOT-BORER BEETLE (*Xyleborus dispar*).—The shot-borer beetle is harmful not only to the plum, but also to apple and pear. The beetles are very small, the female measuring about $\frac{1}{8}$ inch, and the male one-third smaller. They are black or black-brown in colour, with rows of punctures down the wing-covers. The short antennæ are clubbed at the apex.

The beetle bores into the wood of healthy trees, making from this first tunnel one or more others which run round the stem; from these, other tunnels are made in the longitudinal direction, and in these the eggs are laid. The grubs from the eggs feed on the sap which exudes, and on the fungi which grows in the borings. The attacked trees die off.

Treatment.—Cut and burn attacked stems and branches. Fresh poles of any tree that the shot-borer infests could be placed here and there in the orchard, with one end fixed in the soil. The beetles will use these for

their egg-laying, and before the new brood is ready these trap poles should be removed and burned. A succession of such traps could be prepared from March or April onwards.

Fruit-tree Bark Beetle (*Scolytus rugulosus*).—This is another small beetle which is found infesting plum, cherry, apple, pear. The female beetle makes a gallery in the longitudinal direction, and along the sides of it lays her eggs. The eggs hatch into legless wrinkled white grubs with brown heads. These grubs bore galleries at right angles to the mother gallery, and at the end of the gallery pupation takes place, the mature beetles when ready boring through the bark to the outside. Whether the galleries and pupal beds are almost entirely in the bark, or to a greater extent in the outermost youngest wood, depends on the thickness of the bark at the place of attack.

Winter Moth (*Cheimatobia brumata*).—Fore wings of male light brown with many fuscous marks and striæ. Hind wings pale fuscous with several faint darker lines. The wings of the female do not reach half the length of the abdomen. The caterpillar is a looper, having six thoracic legs and only two pairs of prolegs; the colour varies, but after the caterpillars have been feeding for some time the colour is green or green-yellow with brown heads and white stripes down the body.

The moths issue from the chrysalids in the soil from October onwards, and proceed to lay their eggs on buds and branches. By March the eggs may have hatched. The full-grown caterpillar, measuring $\frac{3}{4}$ of an inch, spins down to the ground on a thread, and enters the soil for pupation.

March Moth (*Anisopteryx aescularia*).—Fore wings of male brown or yellow-brown with transverse bands; the hind wings pale whitish-brown with a zigzag line running across them. The female is wingless, and has a pencil of hairs at the tail-end; colour brownish-yellow. The caterpillar is a looper, yellowish-green in colour, with a darker green line edged with yellow down the back; there are pale yellow side-lines. The moths issue, from cocoons in the soil, in March, and the females lay their eggs in regular rows, in bands round the twigs, the eggs being embedded in hair from the tail-end. The caterpillars can be full grown in May, when they descend into the soil for pupation.

Mottled Umber Moth (*Hybernia defoliaria*).—The male varies much in colour. Fore wings brown-yellow with dark transverse bands; hind wings pale, and with a brown spot near the middle. Female has the wings abortive, and shows dark spots along the back. The caterpillar is brown, with a bright yellow stripe along each side and white spiracles; it is a looper; when full grown it measures $1\frac{1}{4}$ inch. The moths begin to come away in October, the females laying their eggs in rows on bud and twig; the eggs hatch first in March, and the caterpillars are full grown from May onwards.

The looper caterpillars of these three moths in some seasons do very great damage to plum, apple, damson, nut and other fruit and forest trees, sometimes defoliating the trees infested.

Treatment.—Take advantage of the fact that the females cannot fly but have to crawl up the stem to get into the tree, by preparing, before their issue from the pupal condition, sticky bands so as to trap the ascending females before they have laid their eggs. The sticky or greasy material is spread on bands of grease-proof paper, each band being about half a foot wide. These bands round the stem should be securely fastened above and below by string, and should be placed 4 or 5 feet above the ground.

The banding should begin in October. Where the fruit land is cultivated chrysalids in the soil might be destroyed by digging or hoeing, in late summer, round trees that had been infested in spring.

If the caterpillars have got to work, spray the trees with Swift's arseniate of lead or with Paris Green, 1 lb. of Blundell's Paris Green to from 200 to 280 gallons of water, according to the species of tree and the age and condition of the leafage.

Plum Aphis (*Aphis pruni*).—In some seasons this is an extremely harmful pest. Eggs are laid in the autumn on stem and twig. These eggs remaining over the winter hatch in March of the next season, the young from the eggs developing into wingless females, dull purple in colour, and these in turn give rise to live young. The life-history is complex. From the puncturings by the proboscides of the aphides the leaves curl.

Treatment.—The important point to attend to is that treatment take place before the leaves have curled. Whenever the leaves curl, the enclosed aphides are protected from the spray. The trees should be treated before bud bursting with emulsion soda wash (*see* Apple Blossom Weevil). A careful outlook should be kept, and if the aphides be noticed at or after bud bursting, then they should be killed by a spray of dilute paraffin emulsion, or of soft soap and quassia.

Mealy Plum Aphis (*Hyalopterus pruni*).—This species appears on the underside of the leaves, in late June or in July. It is recognisable from *Aphis pruni* by its being covered with a dense white mealy excretion. This aphis also gives out quantities of honey dew. The mealy excretion makes this aphis difficult to kill. Theobald recommends as a result of a correspondent's successful experiments, paraffin emulsion with liver of sulphur added at the rate of 1 lb. of liver of sulphur for every 100 gallons of paraffin emulsion wash.

Cherry.

Cherry and Pear Sawfly (*Eriocampa limacina*).—The larvæ of this sawfly are injurious to the leafage of cherry, pear, apple, plum, damson and peach, and various forest trees. The upper epidermis of the leaf and the soft tissue between the veins is eaten away. The dark-coloured sawflies appear in June, and the female saws a series of oval slits in the cherry leaf, one egg being laid in each slit. The eggs hatch into twenty-two footed caterpillars; in the early part of its life the caterpillar is dark green and covered by an exudate of slime, the head is swollen, and the body tapers behind. The full-grown caterpillar—measuring about half an inch—has lost its green colour and its slug-like appearance, and is yellow. It passes into the soil, pupation taking place under cover of a cocoon of silk and earth. There is more than one generation in the year.

Treatment.—The removal, and the burning of the surface soil, in winter, from below attacked trees, has proved itself a useful measure. Digging and hoeing ground in spring under infested plants would disturb and destroy the wintering larvæ or pupæ.

Against the feeding caterpillars, spray with 1 oz. hellebore, 3 gallons of water, 2 oz. of flour kept constantly stirred; or with Paris Green, 1 lb. of Blundell's Paris Green to 200 gallons of water; or with Swift's arseniate of lead. All these sprays are poisonous and must not be used later than four weeks at least before the harvesting of the fruit.

Cherry Aphis or Black Fly (*Myzus cerasi*).—This aphis can be noticed on the plants in spring and onwards; throughout the year the various generations are produced. The collections of black aphides are

characteristic, as is also the great exudation of honey dew which falls on leaf and shoot and forms a suitable nidus for the development of fungi. The treatment should be timely, *i.e.* early in the season, before infestation is overwhelming, and before the leaves have curled. A wash of soft soap and quassia should be used.

Raspberry.

Weevils (Genus *Otiorrhynchus*).—Two species of weevil, namely, the Clay-coloured weevil (*O. picipes*) and the Red-legged weevil (*O. tenebricosus*), are destructive to various fruit plants. The clay-coloured weevil, besides injuring raspberry, is also harmful to strawberry, apple, plum, damson, gooseberry. The red-legged weevil has been reported as injurious to raspberry, strawberry, plum, cherry, apricot, peach, etc. Damage is done by *Otiorrhynchus*, both as grub and as adult beetle. The grubs live in the soil biting the roots; the adult beetles feed on the above ground parts of the plant. The adult weevils cannot fly, and they are nocturnal in habit, hiding in the daytime. *O. picipes* may measure $\frac{1}{4}$ inch in length. The head and thorax are dark and the wing-covers brown, but are covered with greyish scales, so that the general impression is a clay colour. The weevil is oval in shape, and has the twelve-jointed antennæ ending in clubs. The red-legged weevil measures up to $\frac{1}{2}$ inch in length; it is shiny black, the elytra having rows of punctures.

The female weevils lay their eggs in the soil. The grubs which hatch are yellowish-white in colour, with brown heads and biting jaws; they are legless. Pupation takes place in the soil, in an earthen cell.

Treatment.—Catch the beetles at night by shaking them down on to tarred boards, or on to white sheets spread for the purpose; this treatment has to be repeated. The weevils use as shelter places bands of hay twined here and there amongst the plants; such traps must be regularly visited, and burnt with the sheltering beetles.

To destroy the grubs incorporate vaporite with the soil.

Raspberry Beetle (*Byturus tomentosus*).—This beetle measures about $\frac{1}{6}$ inch in length; it is brown in colour, covered with a yellow-grey pubescence. The grubs measure about $\frac{1}{4}$ inch when full grown; they are yellowish in colour, and have brown heads; there are six thoracic feet, and at the tail-end there are two projections with a stump-like process between them, of service in locomotion. The beetles are destructive to flower-buds and blossom, and the grubs destroy the fruit.

The beetle issues from the cocoon about the middle of May. The eggs are laid in the flower; the grubs on hatching pass into the fruit, where they feed and complete their growth. At the end of the season they leave the fruits and make their way to shelter places, in which, under cover of a cocoon, the winter is passed. These shelter places are cracks in the bark, the soil at the base of the plant, etc.

Treatment.—Shaking the beetles down on to tarred boards or into vessels containing paraffin has proved very useful.

Burn all prunings and old canes, etc., likely to afford shelter to the cocoons.

Bury the surface soil as another measure against the cocoons.

Raspberry Moth (*Lampronia rubiella*).—This moth measures only $\frac{1}{4}$ inch in length and barely $\frac{1}{2}$ inch in spread of wings. The colour of the moth is light brown, with yellow-grey head; the front wings have a number of yellow spots and have brown fringes; the lighter hind wings have light fringes. The caterpillar measures when full grown $\frac{1}{4}$ inch; the

colour is red or pink, with the head and a patch on the next segment black; it has sixteen legs.

The moths fly at the end of May and in June, when the eggs are laid in the raspberry blossom. The caterpillars do not seem to harm the fruits, but leave them, to pass the winter, typically, in the soil below the canes. From their shelter places the caterpillars come in the next spring and ascend the canes; they now bore into buds and feed, and when full fed make a tunnel in the pith below a bud and there they pupate.

Treatment.—Disturb the overwintering caterpillars in their shelter places in the soil and bury them. Smear the bases of the canes in March with a sticky composition to prevent the ascent of the caterpillars when they come from their winter quarters. Cut back and burn infested canes from the end of April to the middle of May in order to destroy caterpillars and pupæ, and so prevent a new brood.

Strawberry.

Ground Beetles.—Typically both adult and grub of the Ground beetles or family Carabidæ are predaceous and carnivorous, but the adults of a few species are vegetable-feeders. The following three species often prove very destructive in strawberry beds.

Pterostichus or *Omaseus vulgaris.*—The beetle is 6½ to 7½ lines long, and shining black in colour. The thorax is rather broader than long, and narrower behind than in front; the wing-covers are striated. There are no wings.

Pterostichus or *Steropus madidus.*—The beetle measures 6 to 9 lines in length. The colour is black, but the thighs may be red. The corners of the thorax are rounded behind so as to show narrower than the wing-covers. The wing-covers show three deep punctures. There are no wings.

Harpalus ruficornis.—The beetle measures 6 to 7 lines long. It is pitch black in colour, with antennæ and legs generally red. The thorax at its base is widely punctured and the hind angles are acute. The wing-covers are striated and in fresh specimens show a grey or golden down. This beetle has wings.

Calathus cisteloides.—The beetle measures 3 to 6 lines in length. The colour is black, with brown-red legs and antennæ. Wings absent or unfitted for flight.

These four beetles hide in the daytime under the straw of the beds or in the soil where their runs may be found. They come out at night and eat the strawberries both green and ripe.

Treatment.—On a small scale go over the beds systematically, removing the straw, section after section, turning over the exposed soil with a trowel and collecting the sheltering beetles.

Messrs. Laxton Brothers of Bedford informed Miss Ormerod that they had succeeded in overcoming these pests on a large scale, thus: "We purchased a large quantity of cheap pudding basins early in the spring; these were let into the ground, level with the surface, at distances of a few yards apart, and kept baited with pieces of lights and sugar-water. When the weather was dry we often caught half a basinful of a night, until the number gradually diminished. The process is laborious but well worth the trouble, as we have lost no fruit this season."

Black Vine Weevil (*Otiorrhynchus sulcatus*).—This weevil measures ⅜ inch. The colour is black, with grey hairs on head and thorax and yellow hairs on the furrowed elytra.

The females lay their eggs in summer and the grub stage lasts over the winter and till the next March. The pupal stage is assumed in spring, and the adult beetle issues in two weeks after pupation. The weevils damage the shoots and runners, and the grubs attack the roots and burrow into the crowns. (*See* under Raspberry.)

Currant.

Shoot and Fruit Moth (*Incurvaria capitella*).—This moth measures about half an inch in length, and just over half an inch in spread of wings. Head deep yellow; forewings dark brown, each with a yellow band and two light yellow spots. Hind wings purple grey and ciliated.

The female in May lays her eggs in the young currant fruit, and the caterpillar, on hatching, feeds on the seed. In June or July the caterpillar leaves the fruit, and passes into a resting condition inside a white case which is attached to bud scale or bark. This stage lasts till the next spring, when the caterpillar tunnels into bud and young shoot to renew its feeding. It is full grown in April or May.

Treatment.—In winter, wash with the emulsion soda wash (*see* Apple Blossom Weevil) to kill the hibernating caterpillars. Infested drooping shoots should be hand-picked and burnt before the issue of the moth.

Currant Clear-Wing Moth (*Sesia tipuliformis*).—The caterpillars are harmful to red and black currant by tunnelling in the shoots. The little moth, measuring an inch or over in spread of wing, is known as clear-wing, from the transparent scaleless wings which are bordered with black. The caterpillar is yellowish, with the head brown; there is also a plate on the segment behind the head; it has sixteen legs. When full grown, the caterpillar measures $\frac{3}{4}$ of an inch.

The eggs are laid singly near the buds, and the caterpillar on hatching bores into the centre of the shoot and tunnels the pith. Pupation takes place in the stem just under the epidermis, and when the moth is ready to issue, the skin is broken by the wriggling chrysalis and the moth escapes.

Both currant and gooseberry shoots are attacked. The leaves of infested shoots wither, and the shoots die off. Black currant is the most commonly infested, but red and white currant are also attacked.

The Currant Aphis (*Myzus ribis*) and the Currant Blister Aphis (*Rhopalosiphum ribis*) are very harmful in continued warm, dry weather. They may be found on the leaves from April onwards.

Myzus ribis is found on black currant, red currant, and gooseberry, while *Rhopalosiphum* attacks red, black, and white currant, and also gooseberry. With both species there are various generations throughout the year from April to August, a sexual generation appearing towards the end of the season. The eggs from this generation remain on the plants over winter, and, hatching in the next spring, give rise to the forms which start the year's cycle. *Rhopalosiphum* living on the underside of the leaves gives rise to red and orange blisters. *Myzus* may give rise to blisters, but more characteristically causes a curling of the leaves.

Treatment.—Prune hard in the autumn following attack, and burn the prunings with the contained eggs. Wash in February with the emulsion soda wash (*see* Apple Blossom Weevil). A careful outlook should then be kept for the appearance of aphides that have escaped treatment, and these should be sprayed with paraffin emulsion before they have had time to shelter under cover of blister or curled-over leaf.

White Woolly Currant Scale (*Pulvinaria ribescii*).—This scale receives

its name from the white woolly material secreted by the scale, and under cover of which the eggs may be found. The fertilised females hibernate, and in the next May proceed to lay their eggs. The young swarm over the plant in June and July. Several moults take place, and males and females are found in the autumn. Red, black, and white currants may suffer infestation.

Treatment.—Wash in late winter with emulsion soda wash (*see* Apple Blossom Weevil).

Currant Gall Mite (*Eriophyes ribis*).—This mite is the cause of the so-called big bud of the black currant. All cultivated varieties of black currant suffer. The mites in feeding in the beds so wound the young leaves with their mandibles, that the buds swell greatly. Badly infested buds fail to burst.

The mite is practically invisible to the naked eye, measuring scarcely $\frac{1}{100}$th of an inch in length. On magnification, the mite is seen to have an elongated body, the abdomen of which has a series of transverse rings. The broader front end is protected on the upper surface by a furrowed shield. In front are four short legs.

The mites shelter in the buds over the winter. There may be a migration in March from buds that have not been too spoiled to expand, but the main migration is from badly infested buds so destroyed that they do not expand, and from partially infested buds that have opened late. This migration takes place from about the middle of April onwards to the middle of June. It is at this migrating period that the pest can be most satisfactorily fought, the mites at this time being exposed on shoots, leaf-stalks, flower-stalks, flowers, and round the young buds. The migrating mites are adult, and, having entered new buds, the females proceed to their egg-laying.

Treatment.—Cultivate from clean stick only. Hand-pick and burn the smaller buds where there is an isolated attack. Dust with a mixture of lime and sulphur; one part of unslaked lime to two parts of flowers of sulphur should be mixed together and dusted on the bushes at the end of March or beginning of April, again in the middle of April, and again in the first week of May. The purpose of this dusting is to reach the migrating mites. This treatment is founded on the facts of the life-history already observed. There is still the possibility that details may still be lacking for a complete life-history.

Gooseberry.

Magpie Moth (*Abraxas grossulariata*).—The caterpillars of this moth are destructive to the leafage of gooseberry and currant.

The moth measures an inch in length and $1\frac{3}{4}$ inch in spread of wings. Typically the body is yellowish, with a black spot on the thorax and black spots down the back; the wings are characteristically dotted with black spots. The caterpillar is a looper, with three pairs of thoracic feet and only two pairs of prolegs; full grown, it measures an inch and a quarter in length; the head is black and the body yellow-white with black spots; there is an orange-coloured band on each side. The pupa is black with yellow rings.

The moths issue in late summer and lay their eggs on the leaves. The young caterpillars do not do much harm before passing into winter quarters. The winter is passed by the young caterpillars in shelter places in cracks and crevices, or in the fallen leaves, or a little way into the soil. In the next spring the caterpillars issue from their winter quarters, and ascend the bushes, and now in completing their growth in feeding off the young foliage they do great harm. They are full fed in May and June.

Treatment.—When the caterpillars have been seen in autumn, the ground below the bushes should be covered with quicklime, and dug deeply in, early in winter. Against the feeding caterpillars spray with Paris Green 1 lb. to 200 gallons of water in autumn, 1 lb. to 250 gallons in spring; or spray with Swift's arseniate of lead.

GOOSEBERRY AND CURRANT SAWFLY (*Nematus ribescii*).—The caterpillars attack gooseberry and red currant. The caterpillars vary in colour with different moults. At first almost white, they, after the first moult, are green with many black spots. When full grown they are green and without spots, but the first and last joints are yellow. The caterpillars are twenty-footed. The oval cocoons are generally under the soil below the food plants, but the cocoons of the first brood may be attached to the stems and branches.

The female lays her eggs in May, on the underside of the leaves. The caterpillars on hatching feed on the leaves, and when they are in great numbers, the plants may be almost defoliated. There are several broods in the year.

Treatment.—Bury the surface soil in late autumn or winter. Beat or roll the soil in spring below the bushes that were infested, to prevent the exit of the adults from the cocoons.

Against the caterpillars spray with hellebore, 1 oz. of hellebore to 3 gallons of water and 2 oz. of flour. Hellebore is a poison, and should not be used within six weeks of the collecting of the fruit.

BROWN GOOSEBERRY AND CURRANT SCALE (*Lecanium persicæ*, var. *coryli*).—This insect infests red, white, and black currant, and also gooseberry. The scale is present on the branches, which are drained of sap by the sucking proboscides of the scales. The winter is passed in the larval, or it may be the egg, stage.

Treatment.—Emulsion soda wash (*see* Apple Blossom Weevil).

GOOSEBERRY RED SPIDER (*Bryobia pretiosa*).—The family Tetranychidæ contains mites of three genera harmful to plants, namely, *Tetranychus*, *Bryobia*, *Tenuipalpus*. *Bryobia* has projecting scales on the front part of the body, and its front pair of legs is longer than the body; *Tetranychus* has no scales, and its front legs are longer than the body; *Tenuipalpus* has no scales, and its legs are short.

The gooseberry red spider is also found on ivy. Sometimes from March and April onwards these red spiders are in such swarms on the leaves of the gooseberry that the leaves are discoloured and die. The fruit may as a consequence fall prematurely. Winter is passed in the egg stage, but the mites may hatch early in the year.

Treatment.—Wash with emulsion soda wash (*see* Apple Blossom Weevil). Against the mites during their active life in spring and summer, spray with paraffin emulsion, to which liver of sulphur (sulphide of potassium) has been added.

Fruit Growing.—For many years past there has been a continuous expansion in the area of land in Great Britain devoted to fruit, and recently a like extension has taken place in Ireland. The Agricultural Returns do not show the full extent of the increased acreage, in the first place because they cover only holdings exceeding one acre, and in the second place because many orchards and gardens attached to residences, considerably over one acre, are also left out of the returns. Fruit is grown more or less in almost all gardens of any considerable size, as well as in thousands of allotments, and planting has become much more general than

it was in earlier times. Therefore, while it is probable that the area of fruit grown on farms and in market gardens, as given in the Agricultural Returns, was never much more than half the total for the country, it is certain that the increase is very much greater than the official figures indicate. Those figures, however, are the only ones available, and, defective though they are, they show the increase that has taken place on agricultural holdings, including market gardens. That is to say, they show this in reference to hardy fruit; for there are no statistics dealing with fruit grown under glass.

The figures in the Agricultural Returns are in two divisions, those of orchards and small fruit. These figures overlap, as a great quantity of small fruit is grown among trees in orchards, and this is included with small fruit grown elsewhere.

The first official returns of orchards in Great Britain were collected in 1871, when they were far from being accurate, as proved by corrections in subsequent returns. Taking the figures for 1873 as the earliest that were approximately accurate, they may be conveniently compared with those of the three decennial periods ending with 1906 for the chief divisions of Great Britain :—

Area of Orchards in Great Britain.

	1873. Acres.	1886. Acres.	1896. Acres.	1906. Acres.
England . . .	143,295	195,071	215,642	241,341
Wales . . .	3,052	3,341	3,677	3,818
Scotland . . .	1,874	1,872	1,935	2,528
Great Britain . .	148,221	200,284	221,254	247,687

Kent stands highest for 1906 among the English counties with 29,788 acres of orchards, followed by Hereford with 28,328 acres, Devon with 27,547, Somerset with 25,531, Worcester with 22,936, and Gloucester with 20,613. Cornwall is the only other county returning as much as 5000 acres. Brecon is the only Welsh county containing as much as a thousand acres, the area in it being 1205 acres. In Scotland no county has a thousand acres of orchards. Lanark has 823 acres, and Perth has 625, while only Stirling, Ayr, and Haddington in addition have over a hundred acres each. There is no return of orchards for Ireland. The area in the Isle of Man and the Channel Islands is 1318 acres. The figures in the table show an increase in Great Britain for the twenty years ending with 1906 of 47,403. Probably, if all the space occupied by fruit trees in orchards, gardens, and allotments not exceeding one acre in extent could be given, the increase would be found to be double the area shown in the table. Still, that increase represents a very important addition to the fruit-producing resources of the country, as it consists almost entirely of orchards planted for market purposes, and with some of the best varieties of fruit of the several classes, as contrasted with the cider apple orchards which cover most of the area returned for some of the counties named above. By far the greatest increase has taken place in Kent, where very little cider is produced, and other counties in which commercial fruit growing has expanded greatly are Gloucester, Worcester, Bucks, Cambs, Norfolk, Somerset, Essex, Devon, Hereford, Middlesex, Warwick, Sussex, and Yorkshire.

As the orchard area of Scotland increased by only 656 acres in the

twenty years, it follows that there have not been any great expansions in any of the counties. Lanark stands first with an extension of 241 acres, Perth coming next with 139, while Stirling has 101.

With respect to the kinds of the fruit grown in the several English counties, it is difficult to generalise, as most of them are grown more or less in nearly all the chief fruit districts of England. Kent and Middlesex are comprehensive as great producers of apples, plums, cherries, all bush fruits and strawberries, with more pears than are grown for market in many other counties. The western and south-western counties grow apples mainly, and pears to a moderate extent; but plums predominate in the Evesham and Pershore districts of Worcestershire, and are grown also extensively in Gloucestershire. Devon and Cornwall produce very little stone fruit. In the Midlands apples are largely predominant; but plums are most in favour in Cambs and districts of counties bordering upon it, with cherries locally. Damsons are more or less extensively grown in Kent, Derbyshire, Lancashire, Cheshire, Shropshire, Worcestershire, and Wales. In these and most other parts of the country they are planted mainly as shelter trees for apples and plums.

In Scotland the most important district for apples and plums grown for market is the Clyde Valley, from Lanark to near Glasgow, parts of Perthshire, including the Carse of Gowrie, coming next in importance. Cherries are not grown to any appreciable extent for market in Scotland.

Small fruits were first returned officially in 1888, when, apparently, the acreage was overrated, so far as agricultural holdings and market gardens were concerned, in England, Wales, and Scotland alike. The reason for coming to this conclusion is that corrections made in 1897 reduced the areas given in 1896 considerably, and, as it is certain that much planting had been done year after year, it is reasonable to conclude that the errors were made in years preceding 1896, as well as in that year. There are no means of correcting the figures for the years in which they were erroneous, however, and therefore they are compared below for 1888, 1896, and 1906:—

Small Fruit in Great Britain.

	1888. Acres.	1896. Acres.	1906. Acres.
England	32,776	69,610	71,978
Wales	532	1,275	1,289
Scotland	3,416	5,360	6,959
Great Britain	36,724	76,245	80,226

Without any allowance for the probable excesses of 1888, these figures show that the acreage has considerably more than doubled since that year, even on farms and market gardens. If any estimate could be given for private gardens, it is certain that the increase in the total would be very much greater than it is in the table.

The area under small fruit was first returned for Ireland in 1899, when it was put at 4809 acres; but as it was reduced to 4359 in 1900, and was only 4531 acres in 1905, it may be assumed that the former quantity was overrated. In the Isle of Man and the Channel Islands the area was 437 acres, making the total for the United Kingdom 76,772 acres. By 1906 that total had expanded to 91,510 acres.

Among the English counties Kent stands out far ahead of any other county in acreage of small fruit, with 22,146 acres out of a total of 71,978

acres for the whole of England. Cambridge is a bad second, with 5279 acres, an area followed by 4810 acres for Norfolk, 4521 for Worcester, and 4421 for Middlesex. Yorkshire as a whole, Hants, and Essex are the only other counties which have over 2000 acres of small fruit. No county in Wales grows as much as 150 acres of this produce. In Scotland the only counties credited with as much as 450 acres are Perth, with 2139, and Lanark, with 2040. The progress of Perth in this respect has been remarkable, mainly owing to the growth of the small fruit industry in the Blairgowrie district. In 1896 there were only 853 acres under small fruit in the county of Perth. Forfar comes third, with 419 acres, and Aberdeen fourth, with 373.

Judging from the extremely low prices which growers of fruit obtain in the wholesale market whenever there are even moderate crops, it appears that the expansion of the fruit area for market purposes has been at least equal to the growth in the demand for fruit. But the system of distribution is an utterly bad one, for under it consumers pay more than double what producers receive. In the first place, there is no check whatever upon the prices returned to growers by commission salesmen. But even supposing that the latter are generally worthy of the blind trust which has to be accorded to them, there is a serious obstacle to the remunerative disposal of fruit by growers over which salesmen have no control. This is the exorbitant profit demanded by the retail shopkeeper, who prefers a limited sale at a high price to a great one at a low rate, because his expenses in horses and carts and other outgoings incidental to delivery are kept down by the policy he adopts. But that policy enormously reduces the consumption of fruit, and thus causes gluts in the markets. The retail fruit sellers, then, maintain what may be described as a "vicious circle." By artificially limiting the demand of consumers for fruit, they cause gluts in the markets, which, in their turn, enable them to keep on buying at very low prices. Co-operation has been suggested as a remedy for this bad state of affairs, and it is being attempted at Evesham and Blairgowrie. But it is extremely difficult to carry out with products which vary in quality as greatly as fruit does.

Apart from the effect of low wholesale prices for fruit, however, difficulties of land tenure have had a restrictive effect upon the expansion of fruit growing. Unless a man is prepared to purchase land, which is the best plan when planting is contemplated, he cannot, as a rule, obtain equitable terms for that operation. There is no extensive district in Great Britain besides the Evesham district in which a fair system of granting security to a tenant who plants fruit trees is general. The Evesham custom is practically one of free sale, with the landlord's assent. That is to say, the tenant who desires to quit his holding finds a purchaser for his improvements in planting and attending to fruit trees and bushes, and the landlord accepts the purchaser as the incoming tenant, unless there is some strong reason for rejecting him. Of course the purchaser has to be assured that his rent will not be raised on the improvements he has purchased, or, if it is to be raised, he pays less in proportion for the tenant-right. As a rule, it appears, the rent is not raised, the landlord being satisfied with the security as to the regular payment of rent afforded to him by the large stake which the tenant has in the holding. At any rate the system works smoothly and satisfactorily to landlords and tenants alike.

In other parts of the country, unless a holding is let under the Market Gardeners Compensation Act, a long lease is the best security which a tenant has for fruit planting; but it is not equitable, as the landlord often

finds the value of his farm doubled at the end of a lease, and is able to put the rent up accordingly. Very few landlords will let land under the Act, and although it was intended to be retrospective, in respect of planting done with the knowledge of the landlord and without objection on his part before the Act came into operation, this intention was frustrated by the Law Courts, and the section of the Agricultural Holdings Act, 1906, inserted in order to restore what the Law Courts had upset, is so worded that its efficacy is doubtful. At any rate, the Act does not promote the extension of fruit growing, except so far as it is voluntarily adopted by landlords, and that, as already stated, is to a very small extent.

In many cases landlords provide trees and bushes, tenants planting and cultivating them, without any claim to compensation on quitting their holdings. This is not an equitable arrangement, because the expenses of preparing the land, planting, rearing, and cultivating for years before the plantations pay any profit are very much greater than the cost of trees and bushes.

In choosing the site for a fruit plantation the character of the soil is a consideration of the highest importance. It has often been stated that any land which will grow wheat and mangolds well will serve for fruit, and it is true that it will serve tolerably. But not all such land will sustain fruit trees and bushes in a thoroughly flourishing condition, and intending growers who pay £100 per acre for land in the best fruit districts obtain better value for their money than those who pay only £20 or £30 in parts of the country not specially suitable for fruit. Such deep alluvial soils as those of the Thames and Clyde Valleys suit all kinds of fruit, and so do soils over the Upper Greensand in various districts and over the Thanet and other cretaceous beds in Kent. Apples flourish particularly well on soils over the Old Red Sandstone, while plums in the Pershore district of Worcestershire grow magnificently on stiffish loam over Blue Lias clay. At Evesham, where all kinds of fruit flourish, the soil is for the most part a fine and deep loam over gravel in the valley and over clay on the hills. A brick-earth soil is almost invariably found well suited to fruit.

Climate, of course, affects some varieties of fruit materially, and some of the more delicate varieties of apples which flourish in the south of England do not succeed in the north of that country or in the greater part of Scotland. Indeed, the bleaker parts of these divisions of Great Britain are not suited to fruit at all. A moderate altitude is essential as a partial security against damage from frost, which is a great drawback to success in valleys otherwise well suited to fruit.

With respect to aspect, a slope towards the south or south-east is usually best, while a south-western aspect is satisfactory except where gales from that direction are common. But good success has been attained with fruit planted on slopes in other directions than those named. Where there is no natural protection from the prevailing wind, it must be provided artificially by growing trees, as windbreaks, and high fences. But it is quite possible to shelter too much, as insect and fungus pests flourish in plantations too much closed in, while frost is most severe where the atmosphere is still. A good belt of trees for a windbreak is one in which Austrian pines are planted outside towards the prevailing wind, Canadian poplars coming next, and damsons inside. The *Cupressus macrocarpa* is a much quicker grower than the Austrian pine, and denser in growth as well. But, in the north, it is liable to be killed by frost, and anywhere it is one of the worst trees to be blown down by gales, for the very reason that it makes rapid and dense growth quickly. If topped and

brushed annually until its root growth becomes well established, the tree is less liable to be blown down. It is a good plan to plant windbreaks, and fences also where there are none, a year or two before a fruit plantation is made.

Locality in relation to a good market is a consideration of much importance, and nearness to a railway station is another; but nothing fully compensates for the disadvantage of a soil in which fruit trees and bushes do not grow in full health and vigour.

It is desirable to plant fruit after a heavily manured crop, such as potatoes, or after clover grazed, or tares folded with sheep having cake. The land should be well cultivated and subsoiled as early as possible in the autumn, the steam cultivator being used for the operation if it is available, or otherwise the subsoil plough following an ordinary plough, stirring the soil, while keeping the underneath layer below, to a depth of about 18 inches. But first, if at all wet, the field should be thoroughly drained. If the land is in good condition, and a well-manured crop has been grown in the season immediately preceding the autumn of planting, no manure will be necessary, but otherwise a good dressing of farmyard manure is advisable.

Before marking out the field for digging the holes for trees or bushes, it is necessary to decide upon the crops to be grown. A common plan is that of growing trees with bushes, and sometimes strawberries also between them for a few years, until these plants are too much overshadowed. The inclusion of strawberries disposes of all idea of horse cultivation in two directions—up and down and across, even if it allows that operation to be carried out up and down during the first two years after planting the strawberries. But first let it be assumed that no strawberries are to be grown between trees and bushes, and that the great economy of horse cultivation is contemplated. In that case, although different varieties of apples, plums, or pears require different spaces for growth, if the land is to be used in the most economical manner, such variation of distance between the trees cannot be effected, as there must be uniformity for horse cultivation, and that must be arranged in accordance with the space needed by the most spreading varieties. Again, the stocks on which the trees have been budded or grafted rule the space which each tree of a given variety requires, while the character of the soil in relation to development of wood growth also has a great influence. Now the narrowest space to allow of horse cultivation for five or six years after trees and bushes are planted is 6 feet; and therefore the bushes must be no less than that distance from each other or from trees, while the latter should be planted at distances which are multiples of 6 feet. At the present time bush-shaped apple trees on the paradise stock are much in favour, except for certain varieties of a meagre habit of growth. Such trees, then, may be planted in rows 12 feet apart, and the same distance from tree to tree in each row, with one gooseberry or currant bush between each pair of them, and a row of the small fruit bushes between each two trees and bush rows. The trees will thus be 12 feet apart in the rows; but by planting a tree in one row opposite to a bush in each adjoining row, the diagonal measurement will be a little over 13 feet. A warning may here be given against planting trees on the paradise stock on poor soils, as its habit is too dwarfing for such land, unless very heavy and frequent manuring is contemplated. If half-standard apples on the free or crab stock are to be planted, the distance in the row from tree to tree should be 18 feet to 24 feet, according to the

character of the soil; if standards, 24 to 30 feet. The same directions apply to pears. For plums 12 feet for bush-shaped trees and 18 feet for half-standards will be advisable. The number of bushes of small fruit, of course, will be increased in proportion to the distance of the trees from each other. When the rows of mixed trees and bushes are 18 feet apart, there will be two rows of bushes between them; when 24 feet, three rows.

So far it is assumed that horse cultivation is contemplated. If it is not intended, the rules as to distances may be varied to suit different varieties. For example, on a plot of Stirling Castle apples of bush form, 10 feet from tree to tree would be ample on even good soil; whereas for Bramley's Seedling or Blenheim Orange 12 feet would be needed even for bushes on the paradise stock; and if the trees are 10 feet apart, the bushes will be 5 feet. Similarly with plums, a Victoria requires much more space than a Monarch, as it has a more spreading habit of growth. When strawberries are also to be planted, there may be a row between each two rows of bushes, the plants being 1 foot 3 inches apart in each row, and plants may also be set in the bush and tree rows.

The marking out of the field will be done in accordance with the distance between trees and bushes decided on. This marking can be well done with a ridging plough without its breast, and with a marker attached to it, which will swing over from one side to the other. For the first row a straight line must be marked by sticks. Down this line the plough is drawn, marking the line of the next row with its marker. When all the lines are marked in one direction, the operation is repeated crossways. Then every point at which one mark intersects another will be the place for a tree or bush, except where a roadway is to be left. In each place for a tree a stake should be driven, if the trees are to be staked, and the hole for the tree will be dug around the stake. Bush trees, it may here be mentioned, are often planted without stakes, if they branch out close to the ground, as the branches of such trees are injured by chafing against stakes; but if they are grown on short stems, say 3 feet in length—a plan very advantageous when horse cultivation is contemplated—they require staking as well as half-standards and standards. The stakes, which should not be of greater length above the surface of the soil than the clear length of the tree stems, for the reason given above, should be creosoted up to about 18 inches above their points, so that the protecting coating will cover them a few inches above the land level.

The digging of the holes should be carried on simultaneously with planting; for, if they are dug beforehand, a heavy rain may fill them with water and produce a muddy consistency in the soil, which it may not be possible to remedy in the season of planting. It may here be remarked that the plan of simply digging and subsoiling holes, without doing the whole field, is a very bad one, as such cavities become water holes for the surrounding land to drain into. Where the whole of the land has been subsoiled, shallow holes 2 feet wide each way will suffice for spade work, while the bottoms should be stirred with a fork to provide fine moulds for the roots of the trees to rest upon.

In the choice of varieties of the several classes of fruit, the beginner should be guided by the experience of established growers as to those which flourish in his district. The number of varieties of apples is enormous, and even the small proportion of them extensively grown for market makes a large number. A good set of six culinary apples for succession, which will succeed on most soils, consists of Early Julyan, Lord Grosvenor, Warner's King, Lane's Prince Albert, Bramley's Seedling, and Newton Wonder, or Wellington,

where the last-named is locally successful. Other favourite cooking apples among market growers are Northern Greening, Eclinville Seedling, Bismarck, the Queen, Royal Jubilee, Domino, Norfolk Beauty, Stirling Castle, Potts's Seedling, Lord Suffield, and Annie Elizabeth. Six good dessert varieties for a succession are the Gladstone, Beauty of Bath, Worcester Pearmain, King of the Pippins, where it does not canker, Cox's Orange, and Claygate Pearmain. Where Cox's Orange does not succeed, as it does not in many districts, Allington Pippin may replace it; and similarly Lady Sudeley may take the place of King of the Pippins where the latter is peculiarly liable to canker; while Blenheim Orange on the paradise stock may be preferred to Claygate Pearmain as the latest dessert apple. For private orchards the choice may be much wider, as quality and flavour in such cases are of more importance than yield or appearance.

Among the plums most extensively grown for market are Rivers's Early Prolific, Czar, Early Orleans, Prince of Wales, Victoria, Cambridge Greengage, Pond's Seedling, and Monarch. For private use such comparatively shy bearers as Old Greengage and Coe's Golden Drop should be included, on account of their delicious flavour; while there are others well worth growing.

Pears are not very extensively grown for market purposes. Those most in favour as good yielders are Hessel, Fertility, Williams's Bon Chrêtien, Clapp's Favourite, and Louise Bonne of Jersey. Only the last of these is of particularly choice quality, and for private orchards there is a multitude of delicious pears, including Doyenné du Comice, Marie Louise, Thompson's Beurré Superfin, Beurré Hardy, Fondante d'Antomne, and Winter Nelis.

Cherries are grown chiefly in grass orchards, where they succeed best. A good succession consists of Knight's Early Black, Frogmore, Blackheart, Black Eagle, Waterloo, Amberheart Bigarreau, Napoleon Bigarreau, and Turk. Whinham's Industry, Lancashire Lad, and Keepsake are the gooseberries most extensively grown to sell in a green state, and Crown Bob when ripe. Newer varieties for culinary purposes are Victoria and May Duke. Among black currants Boskoop Giant is steadily superseding Baldwin, Champion, Black Naples, and Lee's Prolific, on account of its smaller liability to mite attack, and the great size of its fruit. Another large variety of Dutch extraction, as a rival to Boskoop, has just been introduced without a name into this country. There is no red currant superior to the old Red Versailles, although some varieties indistinguishable from it are sent out under new names. The old Scotch Red is also a good market variety. Raspberries, occasionally grown between fruit trees, but more commonly by themselves, include Superlative, Hornet, Falstaff, and Carter's Prolific. Among strawberries Royal Sovereign and Paxton are most extensively cultivated by market growers, with Stirling Castle or one of Messrs. Laxton's recent introductions for a late crop.

The best season for planting fruit trees and bushes is November, provided that the leaves are off and the soil is in good condition; but the season lasts till the end of March, and the condition of the soil is of more importance than the period within these limits, as a waterlogged soil is bad for the work. The best of the soil thrown out in making a hole should be spread over the roots, and firmly trodden in. If the field is in low condition a little well-rotted farmyard manure may be added after this soil, the rest of the earth being placed over it. The tree should be tied to the top part of the stake with stout tarred cord, a small wisp of straw being placed between stake and tree to prevent chafing.

Many experienced fruit-growers raise their own trees by budding and grafting, and their own bushes from cuttings; but a beginner necessarily

goes to a nurseryman for what he requires to plant in the first instance, and trees and bushes are now so moderate in price that most growers purchase them rather than undertake the arduous task of raising them. Before planting the trees, it is important to trim the roots, making smooth cuts where they are broken or bruised. The roots should be spread out to their full length when the trees are planted, any that are too long to lie in the hole dug being cut to a shorter length.

To keep hares and rabbits from gnawing the trunks of apples or pears, it is necessary to place wire-netting around each tree or around the whole plantation. In the former case netting of $\frac{3}{4}$ inch mesh and 2 feet wide should be cut into lengths of 18 inches, the cut edges being twisted into each other when the piece of netting has been placed around the tree at its stake. In the latter case mixed mesh netting is recommended, $1\frac{1}{4}$ inch at the bottom and $2\frac{1}{4}$ inch for the upper portion. It needs to be 5 feet wide, to allow of over 4 feet being above the ground level when 8 or 9 inches have been turned outwards at the bottom to lie flat on the ground, pegged in, or kept in position by stones or bricks. Rabbits will scrape holes under the netting unless this precaution is adopted. There is less danger of injury to plums by ground game than to apples or pears; but in some places, particularly close to large burrows, netting is necessary for them also. The trees should have their young branches cut back by at least half their length in the early part of the spring following the planting, a nearly straight cut being made about one-eighth of an inch above a strong bud pointing outwards.

When the trees have all been planted, the bushes can be put in, holes sufficiently large for the spread of roots being dug for them. It is a good plan to leave out every tenth row for a roadway, and that may be a bush row, so as to avoid diminishing the number of trees in a given area. Under this arrangement there are five tree and bush rows and four bush rows between each couple of roadways. In a large field a cross roadway is also desirable. These roadways will be found of great convenience for carting manure on to the plantation and fruit off it, as well as for spraying operations.

Apples, gooseberries, and currants, two years old, are recommended for planting, and pears and plums a year older. Gooseberry bushes are benefited by being cut back in the season of planting to buds pointing upwards, as they are apt to assume a pendant habit of growth. Black currants, if only two years old, should be cut almost to the ground level, to induce them to branch out well, and to throw up suckers from the roots. They should never be trained with single stems, as they often are in nurseries, and as red and white currants should be. Black currants fruit best on young wood, and the more suckers they throw up from their roots the better they are; whereas red and white currants fruit only on wood of more than one year's growth, and suckers from their roots are objectionable. In the case of older black currant bushes, well furnished with branches, it will suffice to cut half of the branches back to three buds from the ground, leaving the others to fruit. Then, in the next season, there will probably be enough young shoots to allow of the older ones being cut back, to produce young shoots in their turn; and this method of training can be maintained year after year with great advantage. Red and white currants, if only two years old when planted, may be left to extend in growth until the second season, when the new wood should be cut back to two or three buds above the older wood, except where a leader is required to extend in order to render a bush shapely.

Cherry trees are usually planted 30 feet apart in each direction; but as they are many years in coming into full profit, plums or bush-shaped apples are often planted between them, and sometimes strawberries also, in order to obtain profitable returns before the cherries yield much fruit. After the fourth year the strawberry plants are removed, and after twelve to fourteen years the plums or apples also, as the cherry trees by that time overshadow nearly all the ground, which is then, if not earlier, laid down to grass, in which cherries flourish best.

In planting apple trees on grass land tall standards should be obtained, to allow of stock grazing under them. It is of the utmost importance to keep a space for each tree at least 6 feet wide in each direction free from grass for some years after planting, until the trees are well established, after which the grass may be allowed to grow close up to them. It is a good plan to dig this space 2 feet deep, placing the turf at the bottom, some of the best soil for the roots to rest upon, and lastly the inferior soil, which can be enriched with manure. The bare space should be kept clean by hoeing and forking until the time has come to sow it with grass seed. Many miserable failures have been made through planting trees in small and shallow holes in grass land, and allowing the grass to grow close up to them at once. Substantial tree guards, of course, are required if cattle or horses are to graze in the pasture, and a piece of wire-netting in addition is needed around each tree as a protection against ground game.

Raspberries are usually planted by themselves in rows 5 feet wide, and 2 feet apart in the rows, one strong cane, or two small ones, being set in each place, and cut back to the height of 1 foot. Strawberries, which are also grown in large fields by themselves in Kent and some other counties, are planted in rows 2½ feet to 3 feet apart, and 13 inches to 15 inches from plant to plant in a row. Cobnuts, grown extensively in Kent, are planted 12 feet apart, and trained usually in cup shape, though some growers prefer the more economical plan of allowing them to grow more naturally, merely thinning out shoots which crowd the centres.

The cultivation of fruit plantations is very expensive where strawberries or culinary vegetables are grown between the trees or the trees and bushes. Where this is not the case, and the planting has been arranged for horse cultivation, the expense is greatly reduced. There are some excellent little cultivators in the market suitable for the work, which can be done in two directions, leaving only a square about 1 foot wide around each tree and bush to be hoed by hand. It is a question whether the annual winter digging, or rather forking, of fruit plantations is necessary so long as horse cultivation can be pursued; but in time the extension of branches of trees, and of bushes also, stops the work.

Good judgment is required for the training and pruning of fruit trees and bushes in the years subsequent to the season of planting. Market growers do not follow the extremely restrictive system of pruning still pursued to a great extent by private gardeners, particularly with apples and pears. It is necessary to prune apple trees, and especially those of weak growth, somewhat severely until they have become well furnished with strong leading branches, after which nothing more than thinning and the removal of unshapely extensions, or those pendant too close to the ground, are found necessary. Root pruning, not to be thought of in great plantations, is necessary to balance the extremely restrictive pruning of branches mentioned above, whereas it is not required when a close approach to natural extension is allowed, and much better crops are obtained under the latter than under the former system of treatment. Plums, pears, and

cherries require less pruning than apples in their early years; but they often need a good deal of thinning, to allow of the free access of sun and air to the interiors of the trees. The summer pruning or pinching of lateral shoots, strongly recommended by many authorities, is not commonly pursued in large market plantations. Pears, it may be here observed, are most commonly grown as large standards in market plantations, though occasionally as bushes or pyramids, the forms usually preferred now for private orchards and gardens.

It is a great mistake to allow trees to fruit before the third season after planting, and then those which are disposed to fruit freely, unless they are particularly sturdy trees, should have most of the blossom cut off. As a rule, neither apples nor plums become profitable until the sixth year after planting, and the bushes between them have to be relied on mainly to meet current expenses from the second or third season to the sixth, unless there are strawberries or vegetable crops also on the land. When strawberries are planted in March, they produce hardly any fruit in the succeeding summer, and it is a good plan to cut off all the blossom, as this greatly increases the sturdiness of the plants and their yield in the following season, when they sometimes pay all the expenses of cultivation, rent, and rates. But when they are planted in August or September, they produce very fine fruit in the following season. The best growers do not allow strawberries to stand more than four years, and many contend that the period should be a year less. Raspberries yield no fruit worth notice in the first season, but often a fair crop in the second. They are usually left to stand fourteen to fifteen years, and gooseberries and currants the same period, or a little longer if grown apart from fruit trees.

Various organic manures, in addition to farmyard or town manure, are used for fruit in Kent and some other counties, such as shoddy, wool waste, horn and hoof manure, waste fish, or manufactured fish manure. It is questionable whether most of them are worth what they cost, and artificial manures are superseding them to some extent. Potash and phosphoric acid are required by all fruits, even more emphatically than nitrogen. As for lime, a soil not well supplied with it should be chalked before planting is done, or powdered chalk or ground lime should be applied in old plantations. As a rule, where artificials are used, the quantities are too small. Half a ton each of basic slag and kainit per acre and 4 cwt. of nitrate of soda would not be too much to apply to a plantation of top and bottom fruit, though the nitrate might well be given in two dressings a month apart in the spring, the other manures being put on in the autumn or winter. Potash has been found particularly beneficial to gooseberries.

The insect and fungoid pests which injure fruit trees and bushes are extremely numerous. Many varieties of birds destroy the buds of plums, gooseberries, and currants, and devour ripe fruit of all kinds, spoiling more than they eat. Insect pests have been dealt with in the article on "Fruit and Fruit Trees, Insect and Mite Enemies of"; "Fungi" are dealt with in a separate article; and the principal "Fungoid Pests" will be dealt with under their proper headings.

The financial results of fruit growing vary enormously, not only in relation to soil, but also in different seasons. Frost often destroys or greatly reduces the crops of plums, apples, pears, and cherries, and occasionally those of strawberries, gooseberries, and currants are more or less injured by the same cause. In years of great production prices are so extremely low that the returns in excess of the expenses of picking, rail carriage, and salesmen's commission, are meagre. Produce from countries

with a warmer climate than our own "take the cream off the market," while the winter trade in apples is overwhelmed by the great supplies from the United States and Canada. Prices for most kinds of fruit are much lower than they were twenty or even ten years ago, one year with another. Therefore, considering the largeness of the capital required for fruit growing and the long time there is to wait before a new venture pays expenses, the profits are not by any means extravagant on the average. Still, where circumstances as to soil, climate, elevation, and nearness to a good market are favourable, growers who thoroughly understand their business appear to make their industry pay fairly, one year with another.

Fruit under Glass.—During the last forty years, and particularly during the last twenty, an immense development in the glass-house industry has taken place. Indeed, so far as the growing of fruit for market is concerned, that industry was hardly in existence forty-five years ago; whereas at the present time it is probable that fully 1500 acres of land are covered with commercial glass-houses, not including the multitude of hothouses in private gardens, some of them very extensive, from which surplus fruit is sold to a large extent. A considerable proportion of the area mentioned is devoted to flowers, and another portion to cucumbers and various vegetables. The tomato is ranked among vegetables, though it is certainly a fruit, and is so treated in this article. About eight years before the date of writing, calculations made after visiting the principal centres of the glass-house industry, and consulting the best authorities in each, brought out an estimate of 350 acres of grapes under glass in Great Britain, 250 acres of tomatoes, 50 acres of stone fruit, strawberries, figs, etc., 100 acres of cucumbers, and 350 acres of flowers. These items made a total of 1100 acres, and a great expansion has taken place in the last eight years.

The development of the taste for tomatoes has had a great influence in the expansion noticed above. The demand for that product has grown so constantly that new glass-houses have had to be erected year after year to meet the demand, in spite of the heavy imports from the Channel Islands and foreign countries. Moreover, the expansion is all the greater on account of the usual plan of devoting hothouses to grapes after the soil in them has become too stale for tomatoes. It is true that the latter are grown largely in pots; but this method of cultivation greatly increases the expense, and vines, or peaches, to a smaller extent, therefore, are commonly planted two or three years after the houses are erected. On this account the area under glass devoted to grapes has increased to a much greater extent than that used for other purposes. One of the most extensive growers of tomatoes near London knew only one man who grew them for market in 1862, and the single ton of the fruit that was produced in the year was too much for the London market. Thirty-seven years later an inquiry led to the estimate that three large growers out of the hundreds who live within twenty miles of London produced 550 tons of tomatoes per annum, and for the whole of England and Wales, without including those grown in the open air, the calculation was 10,000 tons. Probably at the present time the total produced under glass in Great Britain is not less than 15,000 tons.

The most extensive hothouse nurseries in the country are to be found to the north of London, from Finchley and Tottenham to Cheshunt, and still farther north at Stanstead in Essex. At Cheshunt, when the largest grower of grapes and tomatoes in the United Kingdom or any other country started in his undertaking, in 1881, only one man in the parish had a hothouse or two. Seventeen years later the large grower estimated that

there were 125 acres covered with glass. He and his brother alone had 51 acres so covered. The former grew grapes and tomatoes alone, and, although he declined to give the quantities, an estimate derived from outside information made the annual production 140 tons of grapes and 400 tons of tomatoes. His brother grew flowers extensively, but also produced large quantities of grapes and tomatoes, and there were many smaller growers in the parish. The wonderful progress made in seventeen years has been continued up to the present date. Similar progress has been made in glass-house erection in Waltham Cross, Enfield Highway, Enfield, Ponder's End, and other parishes. In 1862 there was only one hothouse in Ponder's End, and not one in Enfield Highway, whereas now there are miles of such structures, which the traveller sees in great groups by the roadside; also in Enfield, Tottenham, Hoddesdon, and neighbouring parishes. Many large nurseries are also to be found in Finchley, Whetstone, and Edmonton. Probably the district to the north of London up to and including Stanstead contains about one-third of the commercial glass-house area of England. To the south, south-east, and south-west of London, as at Mitcham and various places in the Thames Valley, there are also many extensive glass-house nurseries. The district of Swanley, in Kent, is another very important one in this connection, and other Kent parishes in which hothouses are to be found in great groups are Erith, Belvedere, and Bexley Heath, where peaches, forced strawberries, and tomatoes are extensively produced.

Next in importance to the large district north of London already noticed as a centre of the hothouse enterprise, is Worthing in Sussex. Favoured with a mild and sunny climate and a rich soil, Worthing is eminently fitted for the production of early produce, for which among English districts, indeed, it stands pre-eminent. In 1871, when the grower regarded as the pioneer of a great and important local industry started in his undertaking, there were only three or four little glass-houses in the district. By 1898 one of the best authorities reckoned that, in Worthing and neighbouring parishes along the coast on either side of it, from Southwick to the east of it to Littlehampton to the west, the area covered with glass was 70 acres. At present it is probably nearer 80 acres.

Commercial glass-house nurseries are also scattered over many parts of England other than those named above, and in a few districts of Scotland.

In the Channel Islands, and particularly in Guernsey, this industry is carried on very extensively. In Guernsey, indeed, it is the most important industry. Over 30,000 cwt. of grapes and about 300,000 cwt. of tomatoes are commonly exported from the Channel Islands to this country in a year, all but a small proportion being sent from Guernsey. Melons are grown in Guernsey on a somewhat large scale. Apart from the imposing show of glass-houses in great groups near St. Peter's Port, hundreds of cottagers have small structures of the kind in their gardens or small holdings. Most of the latter, and some of the former, are unheated houses.

The principal products of hothouses, apart from flowers, are grapes, tomatoes, cucumbers, strawberries, peaches, nectarines, and figs. In the Channel Islands French beans and potatoes are grown under glass to a considerable extent, as the former are also in some parts of England.

The prices of hothouse products have fallen enormously during the last twenty years, particularly those of grapes and tomatoes. There are living growers who can remember when Black Hamburgh grapes in small quantities made a guinea a pound in May, whereas now 3s. 6d. is a high price even for that period of the season, and later it falls to 10d. or even

to 6d. The high price named was realised only when there were hardly any commercial hothouses in the country; but as recently as fifteen years ago late Gros Colmar grapes kept until January made from 6s. to 10s. per pound, while now the best Gros Colmars rarely realise more than 2s. 6d. in January, and Muscats seldom sell at over 3s. 6d. even at that period of the season. Grapes from Guernsey cool houses frequently fall as low as 4d. per pound in the autumn. Tomatoes, early and late, usually averaged 6d. per pound fifteen years ago, as compared with 3d. or 3½d. at the present time. Vast quantities are sold at 2d. in the autumn. These, of course, are wholesale prices, which are commonly at least doubled in supplying consumers.

For some years after the commercial glass-house enterprise began to make headway, a man with very little capital could erect a house and pay for it with his first crop of tomatoes. Many of the greatest glass-house nurserymen started on a very small scale. At the present time, however, the profits of the industry have been brought within modest limits, and small producers have to work very hard to get a living by it.

Fungi.—More than forty thousand species of fungi have been described. They form a well-marked group or subdivision of the Flowerless Plants, one of their chief features being the absence of chlorophyll or the green colouring matter so common in most other representatives of the Vegetable Kingdom.

Owing to the want of chlorophyll, they are unable to assimilate carbon-dioxide, and are dependent upon the complex compounds of living or dead organic matter for the carbon and most of the other elements of their food.

Fungi, such as toadstools and many moulds which derive their food constituents from dead organic matter, are spoken of as *saprophytes*. Those which obtain their sustenance from the tissues of living plants or animals are termed *parasites*: the smut and rust fungi are typical examples of this class. In some instances fungi which are generally saprophytic may become parasitic under certain circumstances; they are then described as "facultative" parasites; similarly parasites may be facultatively saprophytic, living for a time on dead organic materials.

Parasitic fungi usually do very considerable damage to their so-called *hosts* on which they live, and not unfrequently kill them altogether. A great many destructive diseases of farm and garden crops, such as potato disease, vine mildew, and rust, are caused by the attacks of such parasites. Many cases are, however, known where fungi live more or less parasitically on other plants, and at the same time render certain services to the latter. Such *symbiosis*, or living together for mutual benefit, is met with in certain trees and orchids the roots of which are infected with fungi, whose small filaments act as root-hairs and absorb water and food materials from the surrounding soil and pass them on to their symbiotic companions. The fungi in return for this service no doubt derive nutriment from the tissues of the tree or other plant with which they are associated. The combination of root and fungus is termed *mycorhiza*.

In most lichens a somewhat similar symbiosis exists between an alga and a fungus.

A small number of fungi, such as the yeasts, consist of a single cell, but the majority are composed of long tubular filaments termed *hyphæ*, in which is the living protoplasm and cell sap of the plant.

The whole vegetative body of the fungus apart from the reproductive

system borne upon it, is named the *mycelium.* It usually consists of hyphæ woven together loosely or compacted into flat sheets or string-like strands. The mycelium of a mushroom or toadstool which spreads through the substratum on which it grows is often white and cotton-like, and is popularly termed the "spawn" of the plant. Sometimes transverse partitions or *septa* are formed across the hyphæ, cutting the latter into short cells, each of which becomes separate from its neighbour and capable of germinating into a new fungus.

In most fungi reproductive bodies known as *spores* are formed. They are unicellular structures, each of which on germination gives rise to a delicate hyphæ or germ tube. This in the case of a parasitic species may bore through the cell wall of a living plant or find its way through stomata and other openings into the body of its victim, after which it begins to absorb food material from the latter, and develop a more or less extensive mycelium.

Spores are of many kinds. Some of them arise within spore cases or *sporangia,* and may either be (1) non-motile cells with ordinary cell walls, or (2) naked protoplasmic bodies—*swarm-spores* or *zoospores*—which for a time swim about in drops of water or dew by means of fine vibratile *cilia,* after which they settle down, become rounded off, and then germinate with the formation of a germ tube. In large numbers of fungi spores termed *conidia* arise at the end of the reproductive hyphæ.

In addition to the above asexually produced spores, others are met with in certain classes of fungi which are the product of a sexual fertilisation process. These usually possess thick cell walls capable of resisting drought and moisture, and often germinate only after a more or less lengthy resting period. Such spores when produced in autumn do not usually germinate until the following spring or summer.

The spores of fungi are always very minute, and are readily distributed by means of the wind and by insects; they may also be scattered and carried from place to place by farm and garden implements, and may be distributed on the hands and wearing apparel of those who are brought in contact with the fungi. Such facts must be carefully considered by farmers and others who are anxious to check the ravages of parasitic species which cause disease among their crops.

The following are the chief divisions adopted in the classification of fungi:—

Section A. LOWER FUNGI.

Class I. Phycomycetes.

Section B. HIGHER FUNGI.

Class II. Basidiomycetes.

Class III. Ascomycetes.

The Lower Fungi possess a mycelium which consists of many branched hyphæ without septa or partitions across them. Well-marked sexual reproduction is met with in this section, as well as an asexual method. They are all minute microscopic species. The Higher Fungi have septate hyphæ, and the majority exhibit no sexual process in the formation of their spores. Some are minute, while others, such as the puff-balls and toadstools, may reach a large size.

Class I. The Phycomycetes are divided into two sub-classes, viz. (1) the Oomycetes, and (2) Zygomycetes. Fertilisation in the former sub-class takes place between two sexual cells of different form and size, and results

in a thick-walled resting spore termed an *oospore*, while in the zygomycetes the sexual cells are alike, and give rise to a thick-walled spore known as a *zygospore*.

A large number of the Oomycetes are parasitic, and cause some of the most destructive of all plant diseases.

Important orders in the sub-class are the Saprolegniaceæ or water-moulds, some of which produce disease among salmon and other young fishes, and the Peronosporineæ, which includes the white-rust fungus of cabbages and other crucifers, the potato-disease fungus, the parasites causing vine mildew, onion mildew, damping-off of seedlings, and other common diseases of crops. The Zygomycetes are mostly saprophytes; many of the common moulds, met with on bread and other foods when left in a warm damp place, belong to the Mucoraceæ included in this sub-class.

One small Order, the Entomophthorineæ, are parasites upon flies and other insects.

Class II. or the Basidiomycetes are divided into two sub-classes—(1) the Hemibasidii, and (2) the Eubasidii. They form naked asexual spores; a true fertilisation process is not known in these classes.

The typical Hemibasidii are parasites met with very extensively on grasses and cereals, the chief representatives being the Ustilagineæa group of fungi causing smut, and the Tilletiaceæ, which produce bunt on wheat and other cereals. Allied to this group are the rust-fungi or Uredineæ, many species of which are highly *polymorphic*, *i.e.* they produce several distinct kinds of spores. For example, in wheat-rust five types of spores are met with. Moreover, several of the rust fungi require two different species of host plants for their complete life cycle; the common rust of wheat is a parasite on the barberry bushes in early spring, and later infects wheat.

The sub-class Eubasidii includes a very large number of fungi most of which are of considerable size, and have naked spores, *basidiospores*. The Hymenomycetineæ belonging to it is the largest Order of the fungi, and embraces more than ten thousand species, perhaps the most representative being the Polyporaceæ so common as wound parasites and saprophytes in the form of brackets or shelf-like structures on timber trees and dead wood. In these the spores are arranged in the interior of small tubular pores, readily seen on the underside of the fruiting body of the fungi.

The Agaricaceæ is another large family in this sub-class, and comprises over five thousand species, most of which are umbrella-like, and popularly known as toadstools and mushrooms.

In the Agarics the basidiospores are arranged on the flat *gills* beneath the *cap* of the fungus.

The puff-ball fungi—the Lycoperdineæ—have large spherical or pear-shaped fruit, the spores of which are at first enclosed in the interior of the latter in small chambers, but are set free later as a well-known brownish powder.

Class III. The Ascomycetes are characterised by the formation of an ascus or spore sac in which are generally produced eight spores, although in some cases larger or smaller numbers are present. Sexual organs are met with in some Ascomycetes, but practically all possess the power of reproduction by means of asexual spores of which vast numbers are usually produced.

Belonging to the simplest Order in this Class are the yeast fungi, several species of which are known, some of them being used in the manufacture of beer and other fermented liquors.

Another fungus produces peach-leaf curl.

Among the higher types of this class are the Helvellinæ to which the edible morel belongs; the Tuberineæ or truffles, which produce fruit below ground; the Pezizineæ, a very large Order, many of which have cuplike fruit, often of scarlet, orange, or other brilliant colour.

To it also belong the Pyrenomycetes, an order of great complexity, embracing over ten thousand species. The majority are small dark-coloured fungi, saprophytic, and very prolific in the formation of many distinct kinds of spores. The mildew of chrysanthemums, hops, peas, and roses are common parasitic representatives, as are also the fungi which causes ergot of rye and many grasses.

Nearly allied are the Plectascineæ, an order including the ubiquitous blue moulds, species of *Aspergillus* and *Penicillium,* so common on cheese, bread, jam, and other household materials.

Galloway Cattle.—The province in the south-west of Scotland from which this breed of cattle derived its name was originally much more extensive than the two counties of Wigtown and Kirkcudbright, to which the term Galloway is now exclusively applied. Many centuries ago Galloway comprised—speaking broadly—that extensive area of country which lies to the west of the Caledonian Railway from Glasgow to Carlisle. Until the middle of the eighteenth century the Galloway was the only breed of cattle kept in that wide area. Indeed, in the *Old Statistical Accounts* written from 1790 to 1794, and in other writings of a similar date, they were so closely identified with South Ayrshire that they were quite commonly spoken of as Carrick cattle. Ortelius, the celebrated geographer and author, writing in 1573, says, "In Carrick are cattle of large size whose flesh is tender and sweet and juicy."

They were not numerous in Galloway until after the first quarter of the eighteenth century, the principal farm stock kept previous to that time being sheep, which were specially valuable because of the exceptionally high quality and high market price of their wool. But the Union of England and Scotland opened up a demand which gradually assumed large proportions for lean cattle from Norfolk and the adjoining south-eastern counties of England. This brought about a rapid extension of cattle-breeding, which was found to be much more remunerative than any system of farming hitherto pursued. The trade of sending lean Galloway cattle to the south-east increased so rapidly that at the end of the eighteenth century and at the beginning of the nineteenth nearly 30,000 three- and four-year-old Galloway cattle were annually sent from Dumfriesshire and Galloway, the most of them being driven by road to Norfolk and Suffolk—where they were made fat for the Smithfield Market. The farmers in these English counties, being naturally desirous of saving money by breeding cattle for themselves, took south selected Galloway bulls and mated them with their own native red polled cows, and in this way the present red polled breed of cattle was founded, red Galloway bulls being the class selected. Thus Galloways had an influential part in moulding the red polled breed, whose outstanding merit is its marked success in combining the production of both beef and milk.

Mr. Marshall, who resided in Norfolk from 1780 to 1782, says that long before his time Galloway bulls were used for crossing with the Norfolk

Reid.

Galloway Bull.

Reid.

Galloway Cow.

home breeds (*The Rural Economy of Norfolk*). In the work *The Cattle of Great Britain*, edited by Mr. Coleman, the author of the article on "The Norfolk and Suffolk Red Polled Cattle"—himself a Norfolk man—admits that they owe their origin largely to the Galloways. All he pleads for is "that the old native race had a due share in the concoction of the present breed"—which is no doubt correct.

The native breed in Cumberland from time immemorial was the Galloway. This is explained by the fact that that English county in remote times was under the same rule as the province on the northern side of the Border, and an interchange of blood was secured by the old practice in the times of the Border feuds of the English and the Scotch lifting, or, to use less euphonious language, stealing each other's cattle. In the south-west of Scotland the Ayrshire dairy cattle have to a very large extent supplanted the native Galloways, and in the north of England shorthorns have to some extent taken their place.

Without doubt the Galloway is an original and distinct breed of cattle. Its origin is lost in the mists of antiquity. From time immemorial it possessed the same characteristics of being polled and of possessing superior beef-producing qualities. If not the earliest, it was among the earliest of the breeds of British cattle which were improved. It was the active and lucrative demand from Norfolk which was the first and most influential factor in stimulating this improvement. The annual sales of their surplus cattle furnished the farmers with much larger pecuniary receipts than they had hitherto been accustomed to get, and this consideration produced its natural result. Speaking of this stage in the history of the breed, Smith, in his *Survey of Galloway*, published in 1810, says, "No Bakewells, no Culleys, no Collings have yet appeared in Galloway, who, with a skill, the result of long study and experience, have united sufficient capital, and by the result of their experiments have made great fortunes and transmitted their names to the most distant parts of the kingdom." But the enthusiasm in seeking improvement seems to have been widely spread, and to have brought about marked results. All reliable authorities unite in testifying that the improvement was not brought about by the use of what may be termed foreign blood. Aiton, in his *View of Ayrshire*, written a century ago, sums up this point correctly when he says, "The breed was brought to its present improved state by the unremitting attention of the inhabitants in breeding from the best and handsomest of both sexes and by feeding and management."

During the second quarter of last century the district around Kirkcudbright and the eastern part of Wigtownshire possessed the most meritorious specimens of the breed. A band of skilful men in these localities vied with each other in improving the quality of their native cattle, and they were highly successful. The most enterprising breeders on both sides of the Border procured bulls from these districts—several proprietors showing much liberality and skill in encouraging and assisting their tenants in their laudable efforts to improve their herds. On the English Border Sir James Graham, Bart. of Netherby, had a novel and excellent plan of stimulating and aiding his tenants. He promoted an estate show where, instead of giving medals or money as prizes for the best groups of yearlings and two-year-olds respectively bred by the exhibitor, he gave bull calves from his own very superior herd (see *Field and Fern—Scotland, South*, by The Druid). A Cumberland tenant-farmer, Mr. George Graham, Riggfoot, bought sires bred by Mr. Sproat, Borness, and others in Galloway, with results which have not been exceeded in their

success in the history of any breed. Animals bred by him not only occupied the foremost place at shows, but bulls produced in his herd were the fountainhead of all the best Galloways in subsequent times (*Field and Fern*). In fact, there are few animals entered in the Galloway Herd Book which cannot be traced in direct descent to one bull bred at Riggfoot. Mr. Graham has been designated by The Druid "The 'Black Booth' of Cumberland and the Border Counties," from his having done for Galloways what Booth did for shorthorns; and there is no doubt that the epithet is well deserved. The foundation bull referred to was Cumberland Willie (160), or Borness, as he was at one time named, after the place of his birth. His sire was Galloway Lad (320). Cumberland Willie's (160) sons, which were so influential in improving the breed, were the following:—1. The Squire (18), used for three seasons by Mr. James Graham of Meikle Culloch (afterwards of Parcelstown). Subsequently he was used in the herds of Mr. Walter Carruthers, Kirkhill, and Mr. John Graham of Shaw in Upper Annandale, with very satisfactory results. In his later years he was popularly known as The Blind Bull. 2. Black Jock of Riggfoot (66), own brother to the Squire (18), used in the herds of Mr. Walter Carruthers and Mr. James Gillespie, Annanbank. 3. Brother to Mosstrooper (67), the sire of the best females in the celebrated herd of Mr. James Graham. 4. Gaffer (162), which brought merit and distinction to the herd of Mr. James Grierson, Caigton. 5. Geordie of Riggfoot (234), long the chief of the black harem belonging to Messrs. Shennan, Balig, near Kirkcudbright. He was the sire among other celebrities of Bob Burns (235), which has justly been termed "The Nestor of Black Bulls." 6. Mosstrooper (296), a bull of exceptional distinction both in the show-ring and at the stud. He was never defeated in a long showyard career. He was taken when eleven years old by his owner Mr. James Beattie, Newbie, near Annan, to the Paris Exhibition in 1856, where, notwithstanding his great age, he occupied the premier position among Galloways, attracting much attention from visitors, including the Emperor and Empress of the French, all the more so perhaps because he came from the county of the ancestors of the Empress.

Great improvement in the breed generally was brought about during the last half of the nineteenth century. The Lockerbie Farmers' Club established an annual show and sale (in April) of young bulls in 1851, and this was followed by a similar show and sale at Castle-Douglas in 1855. These sales, at which the choicest male specimens of the breed were disposed of by auction, were the means of diffusing the best blood in all districts where Galloway cattle were bred. By and by the sale at Lockerbie was discontinued, but that at Castle-Douglas has been carried on with great spirit and success until the present day. The champion bull at that show is regarded as having won the "blue riband" for the year of the Galloway breed.

During the last half-century those who have been most prominent and influential in improving the breed are, of course, too numerous to be enumerated. But without being invidious we may specify the Duke of Buccleuch, Drumlanrig Castle; Sir Robert Jardine, Bart. of Castlemilk; Mr. Maxwell Clark of Culmain; Messrs. Thomas Biggar & Sons, Chapelton; Mr. Christopher Graham, Harelawhill; Mr. James Cunningham, Tarbreoch; Mr. Robert Jefferson of Rothersyke; Mr. Andrew Montgomery of Nether Hall; Mr. R. D. B. Cuninghame of Hensol; Mr. Jardine Paterson of Balgray; Mr. Murray Stewart of Cally; Mr. F. E. Villiers of Closeburn; Colonel Dudgeon of Cargen; Mr. William Routledge, Elrig; Countess of Carlisle; Mr. John Cunningham, Tarbreoch; Mr. Parkin-Moore of White-

hall; Mr. H. C. Stephens of Cholderton, Salisbury; Mr. James Wilson, Tundergarth Mains; Mr. David Brown of Stepford; Mr. Montgomery Neilson of Queenshill; Mr. Fox-Brockbank, The Croft, Kirksanton; and Messrs. Nivison, Lairdlaugh.

The Galloway Cattle Society, which was established in 1877, has been very influential in keeping the breed pure as well as in improving it. Its main work has consisted in publishing annually a volume of the Galloway Herd Book, twenty-eight volumes of which have now been issued. About 20,000 females and upwards of 10,000 bulls have been registered. In the first four volumes of the Polled Herd Book, published by Mr. (now Dr.) Ramsay of Banff, 285 Galloway bulls and 690 cows and heifers had been included along with the entries of Aberdeen-Angus cattle. The Galloway Cattle Society, through Mr. Wellwood Herries-Maxwell of Munches, an enthusiastic patron of the breed, purchased from Mr. Ramsay for £75 the copyright of the Galloway entries in the Polled Herd Book. These were re-edited by the Rev. John Gillespie, LL.D., Mouswald Manse (who has been Secretary of the Society and Editor of the Herd Book from the outset), and issued as volume i. of the Galloway Herd Book.

It is chiefly as a beef-producing breed of cattle that Galloways are valuable. Animals of some strains give a copious quantity of milk, but it cannot be claimed for the breed generally that they are deep milkers. However, their milk is exceptionally rich in quality. The Druid, in *Field and Fern*, says, "Hannah (214) gave 20 quarts a day when she was being "caked" for show, and went on nearly at that rate for seven or eight months after calving."

In point of fact Galloways arrive at maturity at different ages, according to the way they are kept when young. As a breed, they have not been pampered. In the low-lying districts they come to maturity from two to three years of age, and in exceptional cases when they are liberally fed they are ready for the butcher even before the former age. Where there is so much diversity in the way they are fed only an approximation can be made of the average weight of Galloway cattle at different ages. As a rule, they are only moderate in weight, but heavy weights have been reached whenever an effort has been made to force forward individual animals for show or other purposes.

The quality of Galloway beef has always been pronounced to be the very highest. From the earliest improvement of the breed this superiority has been acknowledged. Its outstanding characteristic consists in its being well marbled, lean and fat being well intermixed in desirable proportions. The Druid, writing half a century ago, said, "There is no better or finer mottled beef in the world than the Galloway and Angus, and so the Smithfield prices show." To a similar effect Mr. M'Combie of Tillyfour, the celebrated breeder and exhibitor of Aberdeen-Angus cattle, testified, "There is no other breed worth more by the pound weight than a first-class Galloway." For a number of years after the carcass classes were established in connection with the Smithfield Fat Stock Show the Galloways carried off the lion's share of the prizes against all-comers. They have not been competing in these classes in later years.

The Galloway breed from time immemorial has been hornless. The earliest notice of the breed bears out this fact, and seeing no extraneous blood has been used, it is only what could be expected that they should continue to show an entire absence of horns.

The exceptional hardiness of the breed has been an outstanding characteristic of the Galloways. It is admitted on all hands that they are

the most hardy among British breeds of cattle except the shaggy, picturesque long-horned West Highlander, and the difference between the two breeds in this respect is very slight if it exists at all. From the earliest mention of them they have been celebrated for this characteristic, and in all the improvements made on them the retention of their specially hardy character has been steadily aimed at. Originally their colours were varied—black, red, brindled, and duns being not uncommon, but for many years, with trifling exceptions of a few dun ones, they have been "black and all black." Smith, in his *Survey of Galloway*, published in 1810, says, "The dark (black) colours are uniformly preferred, from a belief that they are connected with superior hardiness of constitution." However, ink-black coats are not in favour with the breeders. Those with a brown tinge are preferred. A well-bred Galloway has two coats of hair, an outer and an under coat, the former long, soft, wavy but not curly, and the latter short but thick, mossy, and as soft to the touch as silk. Such a coat keeps out the cold and keeps in the heat. Almost all young Galloways, until the females drop their first calf, are kept in the open fields during both summer and winter, most of them without the option of a shed to take shelter in. The Druid said, "The sky and the hills of the glen are their only winter shelter; and however deep the snow may be, they are kept out in the field." It is found that if the winter diet of two lots of Galloways is the same but one is wintered under cover and the other in the open field, the latter make decidedly more progress during the succeeding summer than the former. This open-air life they lead has no doubt largely contributed to the hardiness of their constitutions and to their general healthiness, especially their remarkable freedom from tuberculosis. An American buyer a few years ago exported eighty head of Galloways to the United States. The veterinary inspector for that Republic subjected all of them to the tuberculin test, and not a single one of them reacted, which is unquestionably a record experience. This exceptional hardiness makes them well adapted for being kept in high-lying exposed situations. Indeed, it is found by experience that they thrive when representatives of more tender breeds would have difficulty in maintaining themselves in existence. Far from being dainty feeders, they readily consume coarse rough herbage and convert it into beef of the best quality. Mellowness combined with a moderate thickness of skin are found in well-bred Galloways.

In being crossed with other breeds Galloways are unusually impressive. In respect of general outlines and character the prepotency of the breed is very marked. While this remark is true in respect to the general configuration of the body of the offspring, it holds good to a degree quite extraordinary that Galloways are influential in getting quit of horns when mated with animals provided with these appendages. A well-bred bull put to a horned cow of any breed secures entire absence of any trace of horns in the produce. In multitudes of cases this has been the experience in mating bulls with West Highland heifers and cows, which have gigantic horns of great length. The same results have been found where a West Highland bull has been mated with a pure-bred Galloway cow. There are few things more remarkable in live stock breeding than the striking off as it were at one stroke such exceptionally long horns. *See* article on Blue-Greys *re* other points in cross breeding.

A considerable number of Galloways are bred in the north of Ireland, and herds are located here and there in different parts of the Midlands and southern counties of England, but the greater number of them are utilised for breeding blue-greys. In the early eighties very large numbers of

pedigree animals of both sexes were exported to the United States and Canada, and smaller consignments have in the interval been sent to the same destinations. Indeed, there are now more registered Galloways in the United States than there are in Great Britain and Ireland. They are found to be specially adapted for the west of North America from being able to stand the rigours of the severe winters experienced there.

The following is a statement of the characteristics of a typical animal of the Galloway breed, drawn up by the Council of the Galloway Cattle Society of Great Britain, 18th April 1883 :—*Colour*, black, with a brownish tinge. *Head*, short and wide, with broad forehead and wide nostrils; without the slightest symptoms of horns or scurs; eye, large and prominent; ear, moderate in length and broad, pointing forwards and upwards with fringe of long hairs. *Neck*, moderate in length, clean, and filling well into the shoulders; the top in a line with the back in a female, and in a male naturally rising with age. *Body*, deep, rounded, and symmetrical; shoulders, fine and straight, moderately wide above; coarse shoulder points and sharp or high shoulders are objectionable; breast, full and deep; back and rump, straight; ribs, deep and well sprung; loin and sirloin, well filled; hook bones, not prominent; hind quarters, long, moderately wide, and well filled; flank, deep and full. *Thighs*, broad, straight, and well let down to hock; rounded buttocks are very objectionable; legs, short and clean, with fine bone; tail, well set on, and moderately thick. *Skin*, mellow and moderately thick; hair, soft and wavy, with mossy undercoat; wiry or curly hair is very objectionable.

Game Laws.

CONTENTS.

I. Introductory.—Generally this article has been treated from the point of view of English law as a basis, important differences being pointed out as occurring. The tenure of land and methods of summary jurisdiction procedure vary in the three countries. While there are often separate Acts dealing with poaching, the provisions of each are as a rule similar.

Differences in detail will be found discussed in Oke's *Game Laws*, 4th ed., 1897 (Scotland), pp. 210 *et seq.*, (Ireland), pp. 235 *et seq.*, but since the publication of this book recent Irish Land Law should be examined as to sporting rights in that country, while in Great Britain the Agricultural Holdings Act, 1906, makes new law as to compensation to tenants for damage done by game to their crops.

The Game Laws are the outcome of a series of statutes passed for the purpose of protecting those who have exclusive or joint sporting rights over lands from the invasion of those rights by the capture or killing of certain wild animals on the lands in question by any unauthorised persons. Wild animals, or animals *feræ naturæ* as the law terms them, were never the subject of larceny at common law (*R.* v. *Townley*, 1871, L. R. 1 C. C. R. 315), and instead of making them so by statutory enactment, and vesting the property of the wild animal in the owner or occupier of the land which it frequents, the law has preferred to invent the series of crimes covered by the term "poaching." Up to quite recent times the right to take game was almost exclusively in the hands of the owner of the land, but recent legislation has gradually given the occupier the right, under certain circumstances—mainly in the protection of his crops—to kill a certain amount of the game found on his land. These statutes will be dealt with hereafter.

II. WHAT IS GAME.—The most general statutory definition of game from the criminal point of view is to be found in the Night Poaching Act, 1828, 9 Geo. IV. c. 69, and the Game Act, 1831, 2 Wm. IV. c. 32, s. 13, and includes *hares, pheasants, partridges, grouse, heath* (*or moor*) *game, black-game,* and *bustards.* The Poaching Prevention Act, 1862, 25 & 26 Vict. c. 114, adds to these *rabbits, woodcock,* and *snipe,* but omits *bustards.* The Game Licences Act, 1860, 23 & 24 Vict. c. 90, s. 2, adds also *quails, landrails,* and *deer*, but the two latter Acts clearly distinguish real game from the added animals. The Acts of 1831 (s. 24) and of 1862 (s. 1) protect the eggs of game birds, and of swans, ducks, teal, and widgeon. The series of statutes known collectively as the Wild Birds Protection Acts, dating from 1880 to 1904, are sufficient to cover all the birds above mentioned and their eggs. The schedule of the Act of 1880 includes only wild duck, teal, and widgeon, but other birds have been added in practically every county by the Orders made under the Act. Copies of these Orders, which are local and extensively advertised over the area they affect, can usually be obtained from the county officials.

III. LICENCE TO KILL GAME.—A licence must be taken out by every person before he shall in Great Britain take, kill, or pursue, or aid or assist in any manner in the taking, killing, or pursuing, by any means whatever, or use any dog, gun, net or other engine for the purpose of taking, killing, or pursuing any game (*i.e.* true game as defined by sec. 13 of the Act of 1831, above), or any woodcock, snipe, quail, or landrail, or any coney or any deer (Game Licences Act, 1860, 23 & 24 Vict. c. 90, s. 4). Lists of licences issued are usually published in the local post-offices. The licences (excepting those for gamekeepers) are available throughout the United Kingdom (s. 18, above). Persons convicted of poaching under sec. 30 of the Act of 1831 lose their licences.

Cost of licences.—Licences taken out after 31st July and before 1st November, £3; to expire on 31st October in same year as taken out, £2; taken out on or after 1st November to expire on 31st July following, £2; for a continuous period of fourteen days to be specified in the licence, £1. The licence to kill game always includes an ordinary gun-carrying licence, but the latter, of course, does not authorise the killing of game.

Exceptions and exemptions.—There need be no licence for taking woodcock or snipe by snares, or rabbits in any way, on permission or by direction of a proprietor of warren or enclosed land, or coursing or hunting hares, or hunting deer, or killing the same in enclosed lands by permission or direction of the owner or occupier. The following persons need take out no licences:—(1) Members of the Royal Family; (2) gamekeepers (appointed

by the Commissioners of Woods) on Crown lands; (3) those assisting a duly licensed person; (4) those killing hares under the Hares Act, 1848, 11 & 12 Vict. c. 29; (5) those killing ground game under the Ground Game Act, 1880, 43 & 44 Vict. c. 47, s. 4. Persons charged with shooting game without a licence may, if this charge fails and the facts warrant, be convicted of carrying a gun without a licence under the Gun Licence Act, 1870, 45 & 46 Vict. c. 72, s. 6. If any persons are found doing an act for which a licence is required, the following persons may demand inspection of the licence, and on default may require him to give his name and address and the place at which the licence was taken out:—Any inland revenue officer, police officer, lord or gamekeeper of a manor, any person having a licence to kill game, the owner, landlord, lessee or occupier of the land upon which such persons may be found. A penalty of £20 may be imposed for refusal to comply with the demands made as above (23 & 24 Vict. c. 90, s. 10). Apparently the person making the demand need not produce his authority (*Scarth* v. *Gardner*, 1831, 5 C. & P. 38).

Taking, killing, and pursuing game is only one offence, and may be charged in one information (*Laxton* v. *Jefferies*, 1893, 58 J. P. 318).

When several persons are out together shooting rabbits, and a game bird gets up and is fired at by any of the party, all who fired are liable to conviction, as it is not necessary to prove who actually killed the bird (*Hunter* v. *Clarke*, 1902, 66 J. P. 247). It need not be proved that a person actually shot any game if he is seen beating about for it, as such action will be taken as evidence of his intention to shoot if an opportunity arose (*Hebden* v. *Hentley*, 1819, 1 Chit. 607).

If a trap be set to kill game a person may be convicted of using an engine to take game, though in fact no game is taken (*Saunders* v. *Baldy*, 1865, L. R. 1 Q. B. 87, and the salmon fishing case of *Ruther* v. *Harris*, 1876, 1 Ex. D. 97). If a trap be set for rabbits and a pheasant be taken, it becomes material to inquire what was the intention of the taker, and obviously if he set the pheasant at liberty he could not be convicted (*Watkins* v. *Price*, 1877, 47 L. J. M. C. 1).

IV. Close Time.—(1) *Game, and certain other wild birds.*—See the table at the end of this article.

(2) *Deer.*—There is no statutory close time in England, but there are certain months in the year (termed *fence months*) during which commoners are shut out of the forests.

(3) *Hares and rabbits.*—There is no statutory close time for killing, but British hares and leverets may not be sold from March to July inclusive (55 & 56 Vict. c. 8, ss. 2, 3, 4). An occupier's right to kill hares and rabbits on moorlands and uncultivated open land and detached portions of the same adjoining arable land of less than 25 acres in extent, is restricted to the period between 1st September and 31st March inclusive (43 & 44 Vict. c. 47, s. 1 (3); 6 Edw. vii. c. 21, s. 2). To give this right the occupier must be in actual occupation of the lands, and not merely a commoner.

Game may not be killed on Sunday or Christmas Day (Act of 1831, s. 3). Setting a snare on Saturday and keeping it open on Sunday, during which day birds are found in it, is constructively a killing on Sunday (*Allen* v. *Thompson*, 1870, L. R. 5 Q. B. 336).

V. The Sale of Game.—Game may be sold to a licensed dealer by every person who has taken out a £3 licence to kill game (Act of 1831, s. 17; Act of 1860, ss. 6, 13). The Acts cited apply throughout the United Kingdom (Act of 1860, s. 13 (*b*)).

Every dealer in game is required to take out two licences, one from the District or Borough Council and one from the Excise. This applies to the United Kingdom. Any person possessing these licences may buy game at any place from any person who may lawfully sell it, and re-sell the same at the licensed place kept by him. He must at his selling place put up on a board his full name and the words "Licensed to deal in game." The licence expires on 1st July following its grant, and costs £2. Innkeepers and persons connected with the carrying trade may not possess a licence (1 & 2 Wm. iv. c. 32, s. 18). An innkeeper may sell game, procured from a licensed dealer, for consumption on his own premises without a licence (Act of 1831, s. 26). No dealer in game may buy or sell, or knowingly have in his control, any game bird after the expiration of ten days (one inclusive and the other exclusive) from the respective days in each year on which it shall become lawful to kill or take such birds of game respectively. Game for the purposes of the licence to deal means hares, pheasants, partridges, heath and moor game, grouse, black-game, and bustards, whether alive or dead, or whether killed in the United Kingdom or in a foreign country.

It is not an offence to have game birds in possession during any prohibited period provided such have been killed within the legal limit (*Simpson* v. *Unwin*, 1832, 3 B. & Ad. 134). This allows of cold storage for consumption out of season. A gamekeeper may with his master's written authority sell game on his master's account (1 & 2 Wm. iv. c. 32, s. 17).

VI. Gamekeepers.—Any person possessing land or the right to follow game on land may appoint a gamekeeper. A gamekeeper's position and powers depend upon the status of his employer, a private person's gamekeeper having less power than one appointed by a lord of a manor or the steward of a Crown manor. A gamekeeper must have a licence taken out by his employer; the cost of this is £2, and there is in addition the ordinary excise male servant duty. The licence expires on 31st July, and is available on land on which the employer has a right to kill game. If the gamekeeper is also to sell game he needs the full £3 licence.

(*a*) *Manorial gamekeepers*.—The lord (or steward of a Crown manor) has special rights of appointment given by the Act of 1831, s. 13. He may by writing under hand and seal appoint one or more keepers to preserve and kill the game within the limits of the manor for the use of the lord (or steward). The keeper may within the limits of the manor seize all dogs, nets, and other engines for killing and taking game used within the manor by persons having no game licence. Seized things become the property of the lord, and he may deal with them as he pleases. The keeper may seize all dogs poaching on the manor if the person using them is without a game licence; but apparently has no right to kill them. The lord may, by deputation, as it is termed, appoint anyone as keeper for the whole manor or part of it to kill game for the use of any person mentioned in the appointment. The person so appointed has all the powers of a gamekeeper and right of seizure, but is not a servant of the lord in the sense that a male servant licence must be taken out for him. In Wales all owners of land worth £500 a year, and provided the lands are not within any manor, may appoint gamekeepers who have by law similar powers to those appointed by the lord of a manor; these powers may by the permission of their owners be extended over lands not the property of the person appointing. A separate deputation is necessary for each person appointed, and must be registered at the office of the Clerk of the Peace for the county in which the manor is situate. If the deputation be revoked or if the keeper quit the employment of the master by whom the licence has been taken out, the licence, as to the person named therein,

becomes of no further effect; it may, however, be renewed free of duty for the remainder of the year for another servant by indorsement by the Excise authorities. In addition to the powers mentioned above, manorial gamekeepers possess all the powers granted to those appointed by private persons. There are no privileged places in Scotland, and hence no manorial, etc., gamekeepers.

(*b*) *Private gamekeepers.*—(1) They may demand the production of licences of persons after game, and require their names and addresses (Act of 1860, s. 10). (2) They may require trespassers in pursuit of game in the daytime to quit their master's land and give names and addresses, and if either request be refused, may apprehend the trespassers (persons hunting or coursing are excepted by the Act of 1831, s. 35). Gamekeepers have no authority to search persons and seize game on highways under 25 & 26 Vict. c. 114, as their powers are strictly limited to the lands of their employers. The police have this power of search and seizure on highways. Any person found by a keeper on his master's lands in possession of recently killed game may demand the same, and, if he is refused, seize it (1 & 2 Wm. IV. c. 32, s. 36). Many keepers make a practice of searching people and vehicles on suspicion, but there is grave doubt whether they have any such right, and, strictly speaking, the keeper should see the game in the possession (actually or on a vehicle) of the person he suspects. Persons found by night (*i.e.* during the period of one hour after sunset and one hour before sunrise) by a keeper on his master's lands may be at once arrested and handed over to the police. If there is resistance, the trespassers may be followed and taken, but some attempt must have been made to effect the arrest on the lands of the keeper's master.

VII. POACHING.—This is the general term applied to criminal offences connected with the illegal taking or killing of game. All these offences are statutory, and are practically on the same legal basis throughout the United Kingdom. They may be roughly divided into (*a*) deer stealing, (*b*) day poaching, (*c*) night poaching.

(*a*) *Deer stealing.*—Deer in England means red-deer, roe-deer, and fallow-deer. Though beasts of forest and chase, they are not strictly speaking game. Deer on enclosed land belongs to the owner or occupier, and is the subject of larceny at common law. The Larceny Act, 1861, c. 96, makes special provision against the unlawful hunting, snaring, killing, wounding, or attempting to kill or wound deer in enclosed land. This offence is a felony (s. 14). The same crime committed in unenclosed forest, chase, or purlieus is summarily punishable for the first offence, and a felony for the second (s. 13). Setting down engines to take deer or pulling down deer fences is also summarily punishable (s. 16). Persons found on land in possession of snares and engines, or venison or parts of deer, and unable to account satisfactorily for their possession, are liable to penalties. Keepers may seize all snares, engines, and firearms they find on their master's land, and any resistance to them is a misdemeanour. A person who kills and carries away a deer, usually kept in a forest, when it is outside of the limits of the forest and on the land of another, cannot be convicted under sec. 14 of the Larceny Act, 1861, of being in unlawful possession of the carcass. The offence must be committed within the limits of the forest, as if the deer escapes on to another's land, being *feræ naturæ*, it is for the time his property, and any killing of it is only a civil wrong against the landowner (*Threlkeld* v. *Smith*, [1901] 2 K. B. 531). The Larceny Act, 1861, applies to England and Ireland. Several Scottish Acts regard deer as game.

(*b*) *Night poaching.*—No persons may use firearms to kill hares, rabbits,

or game by night (Acts of 1831, c. 32, s. 12; 1848, c. 29, s. 5; 1880, c. 47, s. 6). Night means the period between one hour after sunset and one hour before sunrise; and the time is local, not necessarily railway or Greenwich (*Curtis* v. *Marsh*, 1858, 28 L. J. Ex. 36). Entry or presence on land at night of three or more persons together, who, being armed with firearms or other offensive weapons, intend to take or kill game or rabbits is an indictable misdemeanour, and may be severely punished (9 Geo. IV. c. 69, s. 9; 54 & 55 Vict. c. 69, s. 1). If a night poacher assaults or offers violence to any person entitled to arrest him, he is guilty of an indictable misdemeanour (9 Geo. IV. c. 69, s. 2). Prosecutions under 9 Geo. IV. must be instituted within twelve months of the offence, and are triable at Quarter Sessions. Game or rabbits may not unlawfully be taken by night on open or enclosed land, or at the outlets of such land to a public way, or on or at the side of a public way; it is also an offence unlawfully to be on or enter on such land or way with guns or instruments for taking game. The offence may be dealt with summarily, but if repeated a third time becomes an indictable misdemeanour (9 Geo. IV. c. 69, s. 1). The two offences previously committed must have been under sec. 1 and not under any other part of the Act (*R.* v. *Lines*, [1902] 1 K. B. 199). Capturing or killing or setting traps for hares or rabbits in warrens (not free warrens) or ground used for breeding or keeping rabbits is an indictable misdemeanour if done by night, and may be punished on summary conviction. Certain sea and river banks in Lincolnshire as to day killing are excepted. "Taking" means catching and not taking in the technical sense as applied to larceny (*R.* v. *Glover*, 1814, Russ. & R. 269). To obtain game unlawfully by trespass, or unlawfully to use guns, nets, etc., for taking or killing game is an offence, if the accused persons have been found actually in a highway, street, or public place, in possession of game or an implement for taking game which has been either seen, heard, or felt on them by a constable who had good cause to believe that they were coming from land where they had been poaching. Those who are in company with the offenders may be punished as accessories. See Oke's *Game Laws*, 1897, 4th ed., pp. 150 *et seq.*

(*c*) *Poaching by day.*—Personal trespass in the daytime after game, snipe, woodcock, quail, landrail, or rabbits may be punished on summary conviction by a fine not exceeding 40s. If the offender, on demand, refuses to give his name and address, and quit the land, he may be arrested, and if this occurs is liable to an increased penalty (Act of 1831, c. 32, s. 30). Trespass means actual personal trespass, and what constitutes this leads to many disputes between adjoining sporting owners and those who are shooting with them. The following concrete instances may be noted:—(1) A. fires across certain land, standing outside it, an offence is committed in the place in which he stands (*Mayhew* v. *Wardley*, 1863, 8 L. T. 504). (2) A., B., C., and D. are together, A. and B. in a field and C. and D. standing outside to give the alarm; all are guilty either of entering or as aiders and abettors (*R.* v. *Whittaker*, 1848, 17 L. J. M. C. 127). (3) A. enters on B.'s land to pick up game which rose on land where A. had a right to shoot, and which was shot while in the air though over B.'s land. This is no trespass, as the game is B.'s, and he may recover it (*Kenyon* v. *Hart*, 1865, 34 L. J. M. C. 87); but if A. had shot a pheasant which rose on B.'s land and dropped there, and then went in to pick up the bird, he would have been guilty of trespass (*Osbond* v. *Meadows*, 1862, 26 J. P. 439), as the shooting and picking up are in law regarded as one transaction. So where A. shot a grouse on B.'s land the bird having risen there, and left it dead, but returned some hours afterwards in search of what he had killed, he was held to have committed

a trespass, though a keeper had removed the bird, and its shooting had occurred some hours before (*Horn* v. *Raine*, 1898, 62 J. P. 420). A. was B.'s keeper. B. with a party had shot his own land two days before, and several birds were seen to fall in the adjoining wood belonging to C. A. went into C.'s wood, with gun cocked, to look for the dead and wounded birds, but it was held that there was no evidence he was in search of live game (*Tanton* v. *Jervis*, 1879, 43 J. P. 784). Highways are only for the purpose of passing and repassing, and a person who uses them for the purpose of interfering with a drive by abutting owners (in whom the property of the highway is vested) is committing a legal wrong, and has no remedy if he be forcibly prevented by the owners' keepers from spoiling the drive. The owner may also get an injunction against future interference (*Harrison* v. *Duke of Rutland*, [1893] 1 Q. B. 142). See also the case of *Hickman* v. *Maisey*, [1900] 1 Q. B. 752, which still further extends the previous case. A. carries a gun and takes a dog with him along the highway. He sends the dog into an abutting wood, where a pheasant is flushed which flies across the highway, and is shot at by him. A. is trespassing in search of game (*R.* v. *Pratt*, 1853, 19 J. P.). But it would not be sufficient evidence of trespass if a person not carrying a gun sent his dog into a wood from the highway, even if the dog put up game.

There may be two answers to proceedings for trespass—(1) a *boná fide* claim of right, which takes the case out of the hands of the magistrates and compels the prosecutor to proceed by civil action; and (2) absence of guilty mind, *i.e.* belief in the person charged that he had full permission to do what he did (*Scott* v. *Baring*, 1895, 64 L. J. M. C. 200).

VIII. Property in Game.—The right to game and every other kind of animal, whether wild (*feræ naturæ*) or half-tamed, rests on the common law. Before such animals can become the subject of property they must either be caught or in some other way reduced into possession, and from this arises the fact that they cannot be stolen in their wild state. While the law puts an owner of land into the possession of the animals found thereon, though it gives him no property in them, it has protected him, by the series of enactments above mentioned, against the acts of trespassers.

There are four ways of acquiring property in such animals—

1. *ratione soli*, through the possessor's right to the soil;
2. *per industriam*, work and labour spent in taking;
3. *propter impotentiam*, young of game unable to go alone;
4. *ratione privilegii*, privileged rights.

The right of the owner of the soil to all that is killed thereon is the mode of acquiring property *ratione soli*. The owner's possession is reduced into property. In the case of a person acting by licence, or trespassing, the rule still holds good, and, as has been pointed out previously, the latter case is met by the Poaching Acts. Where, however, the rights of adjoining owners are in conflict, the old law of the chase comes into being, and if A. starts a hare on his land and kills it on B.'s, it is not B.'s property *ratione soli*, but A.'s who by his labour (*per industriam*) has acquired it. So also if the hare be started by A. on B.'s land and killed on C.'s, it is A.'s property *per industriam*, though he was trespassing on the land of both B. and C. In other words, it may be said that the property in an animal goes to the owner of the soil as long as it remains on his land, but passes to the hunter when he drives it off the owner's land. Even a landowner cannot keep, as against the master of a pack of harriers, a hare which has been chased from other land and killed on his own (*Churchward* v. *Studdy*, 1811, 14 East 249). One consequence of the rules is that a person may recover from

third parties game or rabbits killed on his land by poachers (*Blades* v. *Higgs*, 1865, 11 H. L. C. 621; 11 E. R. 1474).

If any person captures a wild animal (or bird) and tames it or keeps it in captivity, it becomes his property *per industriam* through the work done in catching and taming. The property in the animal remains only so long as possession lasts; if it gets away, his property is lost, and even if another person catch the animal running free, the tamer cannot recover it from him. If the animal is taken while in possession, the owner can maintain an action for trespass against the taker. The Larceny Act, 1861, 24 & 25 Vict. c. 96, s. 21, provides that "whoever shall steal any bird, beast, or other animal ordinarily kept in a state of confinement or for any domestic purpose not being the subject of larceny at common law, or shall wilfully kill any such bird, beast, or animal with intent to steal the same or any part thereof, shall . . . be imprisoned. . . ." What is meant by "ordinarily kept in confinement" is a question of fact in each particular case; the expression may also be read to mean animals "not found wild in the United Kingdom."

The owner of land has, by reason of his ownership, a qualified property in the young of all wild animals bred on his land; but this property in them ceases directly they are able to take care of themselves. This right arises *propter impotentiam* and was explained by Lord Coke in the well-known *Case of Swans* (1592, 7 Co. Rep. 15 *b*; 77 E. R. 435), who points out that anyone taking young swans from a nest, commits a trespass on the rights of the landowner, who has a possessory interest in the birds.

Cases ordinarily arising are those relating to theft of young game birds being raised under a domestic hen, and are covered by the decisions in *R.* v. *Shickle*, 1868, L. R. 1 C. C. R. 158; *R.* v. *Garnham*, 1861, 8 Cox C. C. 451; *R.* v. *Cory*, 1864, 10 Cox C. C. 23. The gist of these cases is to the effect that young game birds hatched under a domestic hen are, from the law's point of view, domestic animals so long as they remain in coops or runs, or under the protection of their foster-mother, and consequently are during such period the subject of larceny. Nor does it matter whether birds with a foster-mother are confined in a coop or running about with her, whether near a house or distant from it. In bringing a charge for taking these animals, Poaching Acts do not apply, as in the domestic condition they are not game.

Ratione privilegii.—In some places there still exist sporting rights which have been derived from express grant by the Crown, and owners so privileged have property in certain animals even when on the land of another person, if such land be inside the area covered by the privilege. The most familiar example is a Royal forest or chase, in which the Crown, or those who derive their rights from it, are entitled to all the game within the boundaries of the forest on whatever land it may be found. These rights exist in forests and their purlieus, chases, parks, warrens, and manors (*Blades* v. *Higgs*, 1865, 11 H. L. C. 621; 11 E. R. 1474).

A *forest* is a tract of land in which exclusive Crown rights once existed, excluding therefrom the common law relating to game, sporting enclosures, and commons (*Commissioners of Sewers* v. *Glasse*, 1866, L. R. 19 Eq. 134). No one may hunt in a forest without licence from the Commissioners of Woods and Forests (10 Geo. IV. c. 50). Forests are governed by special officers and have special Courts (*e.g.*, Dean Forest, New Forest). Hart, hind, boar, wolf, hare and all beasts of venery are beasts of forest.

Purlieus are lands adjacent to a forest, and which have been disafforested. In them the Crown has the sole right to beasts of forest, chase, and warren, but freeholders may course deer towards the forest, and the forest officers

may enter any lands in the purlieus to drive back forest beasts into the forest.

A *chase* is a forest in a subject's possession, who has all Crown rights except those of officers and Courts. It exists only by royal grant or by prescription founded on lost grant, and may even extend over lands not owned by the grantee (*Robinson* v. *Dhuleep Singh*, 1879, 11 Ch. D. 798). Buck, doe, fox, marten and roe, and all beasts of venery and hunting are beasts of chase.

A *park*, from the legal point of view, is simply an enclosed chase. In addition to the attributes of a chase there must be proved actual enclosure and the existence of beasts of forest and chase within. Lands may be enclosed which are not the property of the grantee if within the limits of the park. Buck, doe, fox, marten and roe are beasts of park. A "legal" park must not be confused with an ordinary park which is merely enclosed land containing deer, any sporting rights in which arise from ownership (*ratione soli*), and not from Royal or other grant (*ratione privilegii*).

Free warren is a royal franchise which gives to the grantee a property in the beasts and fowl of warren on the lands over which the franchise exists, whether owned by the grantee or not. The existence of the franchise is due to Royal grant or prescription, and the right is an incorporeal hereditament (easement) passing only by deed of grant (*Earl Beauchamp* v. *Winn*, 1873, L. R. 6 H. L. 223). The grantee has the right of action for trespass against unauthorised persons hunting within the limits of his franchise, and a right to kill dogs accustomed to hunt therein. Roe, hare, rabbit, partridge, quail, pheasant, heron, woodcock, and rail are beasts of warren. There is no property in beasts or birds not beasts of warren, *e.g.*, grouse, which an owner, or one having licence from him, therefore may kill even in the limits of the free warren (*Duke of Devonshire* v. *Lodge*, 1827, 7 B. & C. 36; 5 L. J. K. B. 319). Free warrens must not be confused with places commonly known as "warrens" which are merely enclosed fields in which hares or rabbits are bred, and which anyone may make. These places are protected under the Larceny Act, 1861, sec. 17 of which makes the animals within them the subject of larceny, these being the property of the owner of the soil, his tenant or assignee. By the same section of the Act rabbits may be lawfully taken in the daytime on any sea bank or river bank in the county of Lincoln so far as the tide extends and within one furlong of such bank.

Manors are franchises derived from the Crown prior to 1290, or by prescription founded on the presumption of lost grant. The lord's right to game is usually on the demesne lands and on the wastes of the manor, *i.e.* the open and unenclosed lands (Act of 1831, s. 10). Where manors have been enclosed under the Inclosure Acts the lord's rights depend on the wording of the Acts, and if no reservations are made therein in his favour, the right to game usually passes to the allottees in freehold of lands enclosed under the Act (*Duke of Devonshire* v. *O'Connor*, 1890, 24 Q. B. D. 468). It does not appear, though the soil is, of course, vested in him, that the lord of the manor has any sporting rights over enclosed copyholds. A lord who wishes to preserve sporting rights after enclosure must carefully make his reservation. The rule of law appears to be that if the soil of the waste passes on enclosure, and there is no expressed or implied reservation in the Act of Inclosure of the sporting rights, these pass to the allottee. Words reserving "all right of hunting, shooting, etc. over the enclosed lands and every part thereof," are sufficient to reserve every right of shooting, territorial or manorial, which the lord might possess (*Ewart* v. *Graham*,

1859, 7 H. L. C. 331; 11 E. R. 332). It was not sufficient in *Lord Leconfield* v. *Dixon*, 1867, L. R. 2 Ex. 202, though the Act reserved to the lord all piscaries, fishing, hunting, hawking, fowling, and all beasts and birds considered as game, to give him the right of shooting over allotments, as there was no particular mention of allotments in the clause relied upon. If, however, the lord merely reserves all his right and interest in every right and privilege *except* the right to the soil, he will lose the right to sport, as that cannot remain if the soil goes, unless the reservation is most explicit (*Robinson* v. *Wray*, 1866, L. R. 1 C. P. 490; *Sowerby* v. *Smith*, 1873, L. R. 9 C. P. 524; *Duke of Devonshire* v. *O'Connor*, 1890, 24 Q. B. D. 468). On the other hand, the effect of the Act may be to vest the soil jointly in the enclosure allottees and the lord, the allottees possessing every right except that of sport, which remains in the lord. Such cases are, however, seldom met with (*Hilton* v. *Bowes*, 1866, L. R. 1 Q. B. 359).

The position may be gathered with exactness from the judgment of Lord Chief-Justice Cockburn in *Sowerby* v. *Smith* (above), who says at p. 531: ". . . The land having been allotted as freehold, the ownership must carry with it all the incidents which ordinarily attach to a freehold interest, unless by the special provisions of the Act some right has been reserved to the lord which would derogate from the ordinary rights of ownership in the soil; and the question turns, therefore, entirely on the effect of the reservation clause . . ." (and speaking of the clause before him at p. 537), ". . . Independently, however, of authority, I arrive at the conclusion that nothing short of a positive reservation to the lord of the right of sporting over the enclosed lands, if not in express terms, at all events in language necessarily leading to such a conclusion, will suffice to entail on land allotted as freehold a burden of a feudal and onerous character inconsistent with the ownership in fee . . ." (and citing with approval another judgment), "It should be remembered that the right now claimed is inconsistent with the useful design of the statute, which was that the lands affected should be held in severalty with a plenary proprietorship unfettered by the rights of others over them."

Common rights.—Common rights (usually existing in manors) of feeding over land do not give any person the right to kill game over the land on which he has the right of pasturage. The soil belongs to the lord; and therefore only to him, or to his licensees, belongs the right of sporting. These rights are protected by sec. 10 of the Act of 1831, and the lord can maintain an action for trespass against all others, including those possessing herbage rights (*Greathead* v. *Morley*, 1841, 3 M. & G. 139).

As to the rights of the lord of the manor on exchange and partition, and the extinguishment of rights of common, see Oke's *Game Laws*, 4th ed., p. 34.

Now that the various rights to sport have been discussed, it will be gathered that unless any given place can be proved to be a forest or its purlieus, chase, park, free warren, or waste of manor, no special sporting privileges are attached to it other than those inherent in every landowner as the possessor of the soil. Where deer, hares, and rabbits are enclosed in—to use popular language—parks and warrens, they are protected by the Larceny Act. Game farms and decoys are trades and businesses, and any person interfering with them is liable to the same penalties as he would be if found interfering with any other trade or business. The person who claims special privileges beyond his ordinary rights as a landowner can have acquired them only by express or implied Royal grant, and to maintain such claim he will be strictly put to the proof. The public, for instance, can never acquire sporting rights by long use. The

rights always belong to some person, either by privileged grant or arising out of ownership, and such person may use his undoubted legal right by stopping at any time people who have all along been but mere trespassers.

Scotland.—The law here as to property in game follows the Roman law more nearly than does the English. There is no recognition of property in game *ratione soli.* Whoever catches or reduces into possession wild game, whatever land it has started on or has gone across, is its owner. There are no privileged places in Scotland such as forests, chases, warrens, and manors.

Ireland.—The law as to property in game is practically the same as that in force in England.

Dead game.—Game dead which has been reduced into possession becomes part of a man's goods and chattels, and consequently the subject of larceny, on a charge of which proceedings may be taken either summarily or by indictment. The game must be described in the indictment as "one dead (pheasant) of the goods and chattels of X. Y."

Eggs.—Though protected statutorily in England, Wales, and Ireland, the eggs of game birds, swan, wild duck, teal or widgeon, do not appear to have any statutory protection *qua* game eggs in Scotland.

By the Wild Birds Protection Acts the taking of eggs of every kind of wild bird may be prohibited wholly or partially. The area of prohibition is settled in England and Wales by the Home Secretary, in Scotland by the Secretary of State for Scotland, and in Ireland by the Lord-Lieutenant. The application to make the prohibition order must come in each case from a County Council. Orders made are usually extensively advertised in the districts which they affect.

Until the recent case of *R.* v. *Stride and Millard*, 1908, 24 T. L. R. 243, there has always been some doubt as to the position of an owner with regard to game birds' eggs. The case shortly was that A., head-gamekeeper to B., a large estate owner, took a thousand pheasants' eggs and sold them to C., a dealer, without B.'s knowledge and consent. A. was charged with larceny and C. with receiving. Defence.—Eggs were of animals *feræ naturæ*, and not capable of larceny. The facts were as follows: In the laying season the eggs of hen pheasants, regularly fed, but running free in the woods, were collected by the under-keepers, and brought by them to the head-keeper, who put them under cooped domestic hens for hatching purposes. The head-keeper sold a thousand of the eggs to a dealer. The Court found that the eggs had been reduced into possession by the collection from the nests, and therefore were the subject of larceny, and upheld the conviction of the two prisoners. It is clear from the remarks of the judges that the eggs of game birds in a "wild" nest are not reduced into possession, and therefore not capable of larceny. The eggs of game birds are, however, protected by sec. 24 of the Act of 1831, which provides that any person not having the right to kill game upon any land—nor having permission to kill from any person possessing the right to kill—who wilfully takes out of a nest, or destroys in the nest, the eggs of any game bird, swan, wild duck, teal or widgeon, or who knowingly has in his possession or control any such eggs so taken, is liable to a penalty of 5s. per egg.

IX. Landlord and Tenant.—Every right of sporting, being an incorporeal hereditament, can only be dealt with by *writing under seal*, hence any other kind of agreement, oral or written, is useless. A shooting tenant who takes a shooting under an ordinary written agreement, not under seal, though he may never have any trouble with the owner, will find himself in difficulties with trespassers after game, and also in going over the lands

he believes himself entitled to shoot on. Having no agreement under seal, he is a mere trespasser, as is anyone to whom he himself gives leave to shoot, and the latter can be prosecuted as a trespasser (*Brigstock* v. *Rayner*, 1876, 40 J. P. 245). The situation may also be awkward for the owner, as without a sealed agreement he will be unable to recover his rent (*Bird* v. *Higginson*, 1835–37, 2 Ad. & Ell. 696; 6 Ad. & Ell. 824).

The common law presumes in every occupier of land by reason of his possession, unless overborne by any of the privileges above described, the right to kill all wild animals found on the land, and the property in all animals there killed, and to exclude from the land trespassers in search of game (*Moore* v. *Earl of Plymouth*, 1819, 7 Taunt. 614). This presumption is, of course, rebuttable by the production of an agreement under seal whereby the landlord reserves to himself any, or all, sporting rights. It has long been customary for landlords in granting leases to reserve to themselves all sporting rights, and consequently where this has been done the tenant may not kill or take game except in circumstances to be detailed hereafter. By the passing of the Game Act, 1831, a change was introduced, the effect of its 7th section being that sporting rights under leases or agreements made before 5th October 1831, for less than twenty-one years, are transferred from the tenant to the landlord; any leases or agreements made after that date, unless expressly reserving sporting rights under seal to the landlord, vest the sporting rights in the tenant. Probably at the present day there are few, if any, old leases, and it may be taken generally that the occupier of the land has the sporting rights unless it has been agreed with him under seal to forego them (*Pochin* v. *Smith*, 1888, 52 J. P. 4). It frequently happens that when a person is found trespassing in search of game on land where the sporting rights have been reserved by the landlord, his defence is "permission given him by the occupier." This, of course, is in law no defence at all, and is specially provided for by sec. 30 of the Act of 1831, and the landlord has a right of summary jurisdiction under sec. 12 of the Act against the occupier for wrongfully giving permission, and generally under the Act against the trespasser. Under sec. 8 of the Act, the landlord has a right to assign his game rights to others, or to give permission to others to take or kill game.

When an occupier may kill game.—If an occupier who has given up his game rights, kills game unlawfully, or unlawfully gives other persons permission to do so, he is liable on conviction to a penalty not exceeding £2 and £1 for every head of game killed or taken, and for the costs of the conviction (sec. 12 of the Act of 1831). It must be remembered also that though an occupier may not kill game he may, unless he has expressly deprived himself of this right by agreement, kill other animals; but by sec. 30 (*b*) of the Act of 1831, though he may give permission to a third party to kill "other animals," such by the Act are not to include woodcook, snipe, quail, landrail, or conies. By the "third party" is not meant a servant of the occupier acting *bonâ fide* on his behalf. A servant, a member of his family, his visitors, are but deputies of the occupier, and what he may do, so may they acting under his orders (*Spicer* v. *Barnard*, 1859, 23 J. P. 311; *Padwick* v. *King*, 1859, 23 J. P. 776; *Coleman* v. *Bathurst*, 1871, L. R. 6 Q. B. 366).

X. Ground Game.—The Ground Game Act, 1880, 43 & 44 Vict. c. 47, applies throughout the United Kingdom and governs the right of occupiers with respect to hares and rabbits. There is an exception for subsisting leases or agreements reserving game rights, made before 7th September 1880. An owner occupying his own land is an occupier under the Act

(*Anderson* v. *Vicary*, [1900] 2 Q. B. 287). The intention of the Act is best gathered from its preamble, which speaks of the interests of good husbandry, the better security for capital and labour invested by the occupiers of land in the cultivation of the soil, and the necessity of protecting the crops of such occupiers from injury by ground game.

The right to kill ground game is in the occupier, as incident to and inseparable from his occupation of the land, concurrently with any other person who may be entitled to take and kill ground game on the same land. This means that any agreement by the landlord to reserve sporting rights shall not override the Ground Game Act. If the occupier does take or kill ground game he must carefully observe the provisions laid down in the Act (and in subsequent amending Acts), which are as follows:—

1. Ground Game shall be killed and taken only by the occupier himself or by persons duly authorised by him in writing (s. 1 (1)).

2. The occupier himself and *one* other person authorised by him in writing are the only persons entitled under the Act to kill ground game with firearms (s. 1 (1) (*a*)).

3. The only persons an occupier may authorise to kill and take ground game are—(*a*) members of his household resident on his holding, (*b*) persons in his ordinary service on his holding, (*c*) any person *bonâ fide* employed by him for reward in taking and destroying ground game (s. 1 (1) (*b*)).

4. Every person authorised by the occupier to kill ground game must produce his written authority on demand by the person having the concurrent right to kill game (*i.e.* the landlord or his sporting tenant) (s. 1 (1) (*c*)).

5. A commoner or a person in occupation for grazing or pasturage for not more than nine months is not an occupier under the Act (s. 1 (2)).

6. In the case of moorlands, and in unenclosed non-arable lands, the occupier's rights under the Act can only be exercised from 11th December to 31st March (s. 1 (3)), but by an amending Act of 1906, 6 Edw. VII. c. 21, this period is ante-dated to 1st September; see also (7), *infra*, as to agreements for the new period.

7. An occupier cannot divest himself wholly of his concurrent right to kill ground game, and even if a tenant lets what shooting rights he possesses he still retains his concurrent rights under the Act (*Morgan* v. *Jackson*, 1895, 59 J. P. 327), such rights by statute being declared inalienable. Any agreement made by the occupier which purports to divest him of his rights under the Act is void in law, and this holds even if the landlord as an extra consideration grants the occupier further benefits (*Sherrard* v. *Gascoigne*, [1900] 2 Q. B. 379); and where an exclusive right of sporting is reserved, the agreement will be held void only as to those parts which contravene the Ground Game Act (*Stanton* v. *Brown*, [1900] 1 Q. B. 671). The Ground Game Amendment Act, 1906, 6 Edw. VII. c. 21, varies sec. 3 of the Ground Game Act, 1880, to the extent that the owner of moorlands and unenclosed non-arable lands, or other persons having a right to take and kill game thereon, may make and enforce agreements for the joint exercise, or the exercise of their joint benefit, of the right to kill and take ground game between 1st September and 10th December, both days inclusive, in any or every year. See Oke's *Game Laws*, 4th ed., p. 105, as to the arrangements which may be made between landlord and tenant whereby the landlord's keeper shall be the occupier's "person authorised in writing" to kill ground game.

8. An occupier need take out no game licence to kill ground game, but of course *every* person using a gun must have the excise licence to carry a

gun. Ground game may be sold without licence by the occupier and the persons authorised by him to kill it, as if he had a licence to sell game.

9. No firearms may be used by any person to kill ground game between the expiration of the first hour after sunset and the commencement of the first hour before sunrise. No poison shall be used; no spring traps shall be used except in rabbit holes.

10. Hares or leverets may not be sold or exposed for sale in any part of Great Britain between the months of March and July, both inclusive (Hares Preservation Act, 1892, 55 & 56 Vict. c. 8). This does not prevent their being killed however, as the only offence is to sell during the close season.

XI. Damage done by Game.—The Agricultural Holdings Act, 1906, 6 Edw. VII. c. 56, which comes into force on 1st January 1909, makes important alterations in the law relating to damage of crops by game, and provides means for the tenant to obtain statutory compensation.

By sec. 2 (1) of the Act, where a tenant has sustained damage to his crops from game, the right to take and kill which is vested neither in him nor in anyone claiming under him (other than the landlord), the tenant having no permission in writing to kill the game, he is entitled to compensation from his landlord if the damage exceeds in amount the sum of over 1s. per acre of the area damaged. Any agreement to the contrary or in limitation of such damage is void.

If the amount of compensation cannot be agreed, the dispute is to be settled by arbitration, but nothing is recoverable by the tenant unless he has previously complied with the following conditions:—

(1) Notice in writing to the landlord as soon as may be after the damage was first observed by the tenant. (2) Reasonable opportunity given to the landlord to inspect such damage—(*a*) if damage to a growing crop, before the crop is begun to be reaped, raised, or consumed, (*b*) if damage to a crop already reaped or raised, before it is begun to be removed from the land; (3) and unless notice in writing of the claim, together with the particulars thereof, is given to the landlord within one month after the expiration of the calendar year, or such other period of twelve months as by agreement between the landlord and tenant may be substituted therefor, in respect of which the claim is made.

By sec. 2 (3) where the landlord proves that by a contract of tenancy made before 1st January 1909 any compensation for damage by game is payable by him, or that in fixing the rent to be paid under such contract, allowance for damage to an agreed amount was expressly made, the arbitrator shall make such deduction from the game compensation which would otherwise be payable as may appear just.

By sec. 2 (4) where the right to kill and take game is vested in some other person than the landlord, the latter shall be entitled to be indemnified by such person against all claims for game compensation given by the Act.

"Game" under this Act means deer, pheasants, partridges, grouse, and black-game. By sec. 1 (2) arbitration proceedings take place in accordance with the provisions set out in Part 1 of Sch. II. to the Agricultural Holdings Act, 1900, before a single arbitrator, and the Act applies to Great Britain but not to Ireland.

General questions as to damage.—Persons legally in possession of sporting rights are required to use their rights in a reasonable manner; if their use is unreasonable they are liable to action. It is actionable, for instance, to tread over fields of standing crops at a time when such a course is not usual or reasonable; or without the licence of the occupier, to turn down

rabbits, which, or the progeny of which, damage the crops (*Hilton* v. *Green*, 1862, 2 F. & F. 821). If game or rabbits brought on to land escape and damage the crops of neighbours, the latter have a common-law right to recover for the damage done (*Farrer* v. *Nelson*, 1885, 15 Q. B. D. 258), and the same rule applies if a sporting lessee overstocks the land by turning down an excessive amount of imported game (*Birkbeck* v. *Paget*, 1862, 31 Beav. 403; 54 E. R. 1194). As to the liability of a person breeding an excessive amount of game on his own land and thereby causes damage to his neighbour's crops, there is no legal decision directly in point, but the remarks of Baron Pollock in *Farrer* v. *Nelson*, 1885, 15 Q. B. D. at p. 260, may be taken as authoritative: "So long as the lessee of the rights of shooting was exercising the ordinary rights which the landlord who had reserved the right might have exercised, he was acting within his rights, but the moment he brings on game to an unreasonable amount, or causes it to increase to an unreasonable extent, he is doing that which is unlawful, and an action may be maintained by his neighbour for the damage which he has sustained.

Authorities.—Manwood, *Forest Laws*; Oke, *Game Laws*, 4th ed., 1897; Warry, *Game Laws*; Archbold, *Criminal Pleading*, 1905 ed.; Stone, *Justice of the Peace.*

XII. Close Time Table.—The close times for wild birds are as follows:—

	England.	Scotland.	Ireland.
Black-game (or heath-fowl (S), moor-game (I))	Between Dec. 10 and Aug. 20, except in Devon, New Forest, and Somerset, where it is Sept. 1, because of the fence months	Between Dec. 10 and Aug. 20 (13 Geo. III. c. 54)	Between Dec. 10 and Aug. 12 (37 Geo. III. c. 21, I.; 37 & 38 Vict. c. 11). *See Note*
Bustard	Between Mar. 1 and Sept. 1	None	None
Grouse (or muir-fowl or red-game)	Between Dec. 10 and Aug. 12	Between Dec. 10 and Aug. 12 (13 Geo. III. c. 54)	Between Dec. 10 and Aug. 12 (37 Geo. III. c. 21, I.; 37 & 38 Vict. c. 11)
Landrail	Mar. 1 to Aug. 1.	Mar. 1 to Aug. 1	Between Jan. 10 and Sept. 20 (37 Geo. III. c. 21, I.)
Partridge	Between Feb. 1 and Sept. 1	Between Feb. 1 and Sept. 1 (39 Geo. III. c. 34)	Between Feb. 1 and Sept. 1 (62 Vict. c. 1)
Pheasant	Between Feb. 1 and Oct. 1	Between Feb. 1 and Oct. 1 (13 Geo. III. c. 39)	Between Feb. 1 and Oct. 1 (28 & 29 Vict. c. 54)
Ptarmigan	None	Between Dec. 10 and Aug. 12 (13 Geo. III. c. 39)	*See Note*
Quail	Mar. 1 to Aug. 1	Mar. 1 to Aug. 1	Between Jan. 10 and Sept. 20 (37 Geo. III. c. 21, I.)
Other wild birds	Mar. 1 to Aug. 1	Mar. 1 to Aug. 1	Mar. 1 to Aug. 1
Wild turkey	None	None	Between Jan. 10 and Sept. 1 (27 Geo. III. c. 35, s. 4, I.)

Note.—As regards game birds, the close season is regulated in England by the Game Act, 1831, s. 3, in Scotland and Ireland by the statutes noted in the table. As regards wild birds not being game birds, the close time

depends on the Wild Birds Protection Acts. Game birds may be killed on the first and the last days specified in the table, but not on any intervening day. In the Irish and Scotch Acts the word black-game is not used, and in the Irish Act, 37 Geo. III. c. 21, it would seem that "moor-game and heath-game" are meant to apply to black-game, or ptarmigan, or both. In 13 Geo. III. c. 54 (5), heath-fowl seems to mean black-game.

Game may not be killed on Sunday or Christmas Day (1831, c. 32, s. 3; *Allen* v. *Thompson*, 1870, L. R. 5 Q. B. 336).

Garden Chafer.—*See* Corn and Grass Pests.

Gardening.

CONTENTS.

INTRODUCTORY.

The art and craft of gardening may truly be said to be the eldest of all human occupations. We have only to turn to the pages of Holy Writ to substantiate this statement, for it clearly states that our first parents, when created, were placed in the Garden of Eden to till and keep it. We find at that early period of human history no reference to other occupations, as farming, law, medicine, etc., and so it may be taken for granted that horticulture was the earliest occupation of man. Adam and his consort Eve must have had a happy and congenial time in pursuing their avocations as gardeners in those ancient days. No weeds, no pests, no troubles presumably harassed the even tenor of their ways, until they disobeyed the Divine injunction to refrain from tasting the forbidden fruit. The result of this lapse from the strict path of rectitude brought perpetual trouble upon our first parents and their successors, and from then to the present day the joys and pleasures of our gardens have been plentifully intermingled with sorrows, anxieties, and worries. Man henceforth had to cultivate his garden by the sweat of his brow, and as the arts of cultivation extended, and the garden developed into the farm, so the tillage of the soil and the growth of crops became more and more arduous, requiring the exercise of greater skill, intelligence, and labour to attain success in the production of vegetable food for the sustenance of the human race.

And, though thousands of years have elapsed since the first gardeners tilled the soil, and thousands of other occupations have sprung up as the result of advancing civilisation, there has ever remained in the human breast a desire and a fascination for the cult of gardening, either as a hobby or a profession. Few, indeed, are human kind who do not inherit from our first parents some trace of love and admiration for so health-

giving, enjoyable, and pleasurable a pursuit. History shows that Noah found pleasure in cultivating the vine; Jacob the vine, fig, and almond; Solomon in fashioning gardens, orchards, and vineyards; the ancient Egyptians, Greeks, Assyrians, and Romans in not only making gardens, but also in cultivating fruits, vegetables, and flowers for use and pleasure. The Chinese, moreover, have from time immemorial been skilled gardeners.

There is no doubt that we owe a great debt of gratitude to the Romans for the introduction of many fruits and vegetables into Britain, and for initiating our forefathers into the art and mystery of horticulture, and its daughter art—agriculture. During the Roman occupation of this island, apples, pears, figs, mulberries, and vines were extensively grown, and later the monks cultivated herbs, vegetables, and flowers as well as fruits to a large extent. After the Norman Invasion and the inhabitants had settled down once more to pursue the arts of peace, gardening again became the favourite occupation.

In the reign of King Henry VIII., gardens sumptuously fashioned became the rage, and during Queen Elizabeth's régime we find that not only was every encouragement given to the extension of horticultural pursuits, but books were written dealing with botany and practical gardening in all its phases. In succeeding centuries the literature of gardening increased by leaps and bounds, and concurrently the practice of the art. The Flemings and the Huguenots were great gardeners, and it is possible that they, too, had a share in stimulating an interest in floriculture in Great Britain, especially in the culture of tulips and other old-fashioned flowers.

In the last century, more especially during the reign of Her late Majesty Queen Victoria, the art of horticulture made rapid advancement. Cottage and villa gardening particularly became very popular, and coincident with this development arose a multitude of societies throughout the kingdom, which especially aimed at promoting an extended love of the art. Greenhouses, too, which were formerly the luxury of the rich, became more and more popular, and now it is a rare spectacle to see a garden without one. Taste, too, in gardening has changed considerably during the last fifty years. At one time formal gardening was greatly in vogue, the gardener having to exercise all his wits to devise the most intricate design in which to lay out a labyrinth of flower-beds, and to plant them in the most fantastic style. Nowadays, beautiful hardy trees, shrubs, and plants garnered from all temperate climes, and formerly regarded as weeds, or as fit subjects to be trimmed and cut into hideous shapes, are grown and esteemed for their natural beauty of form, and planted with a view to displaying a pleasing natural effect, rather than to conform to some geometrical or formal plan. In the same way the landscape gardener endeavours to fashion the garden in a more simple and natural manner, to make it suit the requirements of the plants, rather than to display ingenuity of design. The love of gardening, in fact, has become universal in village, town, and city, and where facilities for practising it on a patch of ground do not exist, it is carried out with success on the roofs of buildings or on window sills.

And last, but not least, in the van of progress of the art and craft is the immense interest taken in the cultivation of allotment gardens. In the neighbourhood of our thriving cities and towns, to say nothing of rural districts, allotments are cultivated by the thousands. A plot of 10, 20 or more rods of ground is a priceless blessing to workers in factory and workshop. The tillage of the soil affords them a splendid healthy exercise, keeps them away from the beershop, enables them to breathe the

sweet pure air of heaven, and to grow an abundance of wholesome fruit and vegetables for the support of their families.

Garden cities, too, are springing up in various parts of the country, the main object of which is to provide comfortable and attractive dwellings and ample garden spaces. There is no doubt that the idea is an excellent one, and will not fail to be appreciated by those who desire to quit the vitiated atmosphere of town or city life to imbibe the purer air of the country, as well as to enjoy the pleasures and delights of a garden.

Primary Features of a Garden.

Having briefly discussed the progress of gardening, we will proceed to deal with the formation of a garden and its cultivation. First of all let us say that it will serve no useful purpose to describe the ideal spot for a garden, beyond remarking that positions facing north or east are not desirable aspects. Most people have to take their gardens as they find them; they cannot change them about as they would a site for the house. Briefly, if a garden has to be laid out let the design be as simple as possible. Let there be no more paths than are actually necessary; provide plenty of lawn space, because there is no finer feature in the universe than a good British lawn, and always make a point of providing bed and border space for flower growing in the sunny parts of the garden. The mistake is often made of forming borders of equal width on all sides of the garden. Thus, if a garden runs from east to west, the north side gets no sun, and flowers will not thrive so well. The majority of flowers like sunshine, so in this case give plenty of space on the south and little on the north side for flowering plants.

If you are partial to Alpine plants and desire to have a rockery, place this in a sunny spot; if you love ferns then choose a shady position for your fernery. Construct both in the simplest manner possible, using stones merely to form small beds and to keep the soil in position, not wedging and fitting them together to represent a triumph of architectural skill. Take a lesson from the rocky ravines of wild nature, and imitate them as nearly as you can.

Make your paths not less than 3 to 4 feet wide, dig out the soil to the depth of a foot at least, put in 6 inches of rough stones or bricks, 4 inches of coarse gravel on this, and finish off with 2 inches of fine gravel, keeping the centre half an inch higher than the sides. See, too, that drains are provided to carry away superfluous water. Wherever possible, give a preference to grass paths; they have a much greater charm than those formed of gravel.

The lawn should also be made with care. Have the soil dug two spits deep and, if poor, well manured. In damp positions it may also be necessary to drain it. Make the surface fine and even and moderately firm. The site may be sown with a good lawn grass mixture in September or March. One pound of seeds, costing about a shilling, will sow a square rod of ground. Sow the seeds evenly up and down the plot, and then again across it. Rake the surface and roll it. In June cut the grass over with a scythe, not a mowing machine, and afterwards once a fortnight with the machine. Roll occasionally in wet weather, and then good turf will be obtained. Turfs, of course, are more expensive, costing on an average 20s. per square rod. If really good turfs free from weeds can be obtained, they make a good lawn at once. They must be neatly laid down, and afterwards beaten firmly with a wooden beater. Where worms are troublesome, spread

a quarter of an inch of fine ashes on the soil before laying the turf. The after-management of a lawn consists of top-dressing it with 4 oz. of basic slag per square yard if the soil be heavy and damp, or the same quantity of bone meal if dry and light. Apply both in autumn. On very poor soils a dressing of well-rotted manure, sifted fine, would be very beneficial. Keep all weeds removed. A dressing of 4 oz. of lawn-sand in April will kill daisies. Worms may be got rid of by dusting with Carter's worm powder, and watering it in. Mossy lawns should be well raked over in autumn to loosen the moss, and then be top-dressed with a bone manure.

Arches and pergolas are pretty features in the garden. They should be as simple in design as possible. Iron arches should be avoided; wooden ones are best. It should be borne in mind that it is not the structures themselves that are desirable as ornaments, but rather the creepers grown on them. So, once they are erected, plant clematises, rambling roses, honeysuckles, wistarias, etc., to cover them and quickly convert them into things of beauty.

A charming feature in a garden is a pond, or lake, or stream, formed with as little suspicion of formality as possible, and with its sides fringed with moisture-loving plants; also its waters dotted with masses of water-lilies and other aquatic vegetation. The depth of the water should range from 3 to 4 feet. Round the margin, bamboos, irises, loosestrifes, royal and other native ferns, also bulrushes might be grown, and in the water the charming forms of water-lilies, as *Nymphæa marliacea*, flowering rush, arrowhead, etc. Beds should be few in number. A much better effect is obtained by providing wide border spaces on the margins of shrubberies for flower growing. If beds are desired, let them be of simple outline. Beds planted with choice rhododendrons and azaleas always make a nice feature on the lawn, especially when lilies are grown between them.

Shrubberies are essential in all except the smallest type of garden. Common trees like the Norway spruce, Scotch fir, Austrian pine, poplars, birch, and lime should be confined to the outer boundaries to serve as screens, and the choicer types of flowering and ornamental-leaved trees brought to the front. Such beautiful flowering trees as the double red hawthorn, double cherry, almond, laburnum, Chinese crab, rose acacia, and snowy mespilus, are a hundredfold more beautiful than limes, poplars, etc., so freely planted in prominent parts of the garden. To intermingle with these, gold and silver hollies, *Cupressus Lawsoniana*, *Berberis Darwinii*, Irish yew, and the juniper are suitable kinds. Then in the way of shrubs, eschew laurels, privet—except in the background—and plant such lovely flowering shrubs as rhododendrons, lilacs, wegelias, Chinese plums, forsythias, *Cytisis andreanus* and *albus*, *Philadelphus coronarius*, and *Olearia Haastii*, intermingled with purple-leaved plums, silver maple, variegated dogwood, box, and phillyreas. Such a border fringed with bold borders of hardy plants will yield a charming effect as the years go on.

Yet another delightful feature of the modern homestead is the wild garden. Here daffodils, squills, crocuses, etc., may run riot and flood the spot with masses of brilliant colour. In summer, pæonies, lupins, delphiniums, etc., together with Japanese roses, will yield a plethora of vivid colouring; and in autumn masses of sunflowers, Michaelmas daisies, kniphofias, and Japanese anemones will render the woodland garden gay almost to the verge of winter. Even on a small scale delightful effects may be obtained in spring by growing masses of bluebells in the shrubberies,

crocuses, snowdrops, narcissi, and cottage tulips in patches on the lawn, on grassy slopes, or round the margin of trees. You simply strew the bulbs on the turf in autumn, plant them where they lie in the soil by means of a dibbler, and then, year after year, they come up and blossom without further trouble. It is, of course, impossible within the limits of an article like this to deal adequately with every phase of fashioning a garden. Enough has been said in a general way to show the main features that should be kept in view in laying out the ground to the best advantage. A good garden cannot be fashioned at once; to get it really perfect and beautiful in all its parts is the work of a lifetime, combined with skill in culture and good taste and judgment in planting.

The Soil and its Treatment.

To ensure a pretty garden and the successful cultivation of its vegetation it is essential to have the soil properly prepared in the first instance. Shallow soils never give satisfaction; the roots cannot penetrate very deeply and the result is stunted growth. When first forming a new garden, make a point of trenching the soil 2 to 3 feet deep. In trenching, however, do not make the mistake of burying the good soil below and bringing the sour soil to the surface. Keep the soil and sub-soil in their relative positions and merely turn them over. Open a trench 2 feet wide and 1 foot deep. Again descend to the lower trench and loosen the lower soil thoroughly with a fork. Place a layer of manure on top, then turn the other foot of soil in the upper trench on this, add another layer of manure, and finally cover with a layer of top-soil. Proceed in this way until the whole of the plot is dug, and fill up with the soil taken out of the first-formed trenches.

The object of trenching is to provide a deep root run, and to loosen the soil to a good depth so that surface water may easily drain below and leave the interstices of the soil filled with warm air instead of stagnant moisture. Crops thrive better in dry seasons in deeply dug soils than in shallow soils, because their roots can descend to the region of moisture, and escape the scorching effects of the sun's rays. Moreover, when air takes the place of stagnant moisture in the pores of the upper stratum of the soil, the latent or locked-up foods in the soils are oxidised and set free for the roots of the crops to feed upon.

Deep trenching is not required every year, only once in three or four years. In the case of flower borders hardy perennials need to be lifted, divided, and replanted every third year, and this is a good time to retrench and manure the border. Similarly, in the case of vegetables, if a three- or four-course system of cropping be adopted, then when the period comes round for growing roots it will only be needful to trench the soil for them.

In other years flower borders will only be required to be lightly forked over, and the vegetable plots dug one spit deep or ridged. The latter method is recommended for heavy soils. The land has to be marked off in strips 2 feet wide, and a trench 2 feet wide and 1 foot deep opened at one end. Turn over the next two spits of top-soil into the trench and then place a third top-spit on the top so as to form a ridge. The ridges should run from north to south, so that in frosty weather the morning sun may thaw the eastern side, the midday sun the centre, and the afternoon sun the western side. Thus, in frosty weather, there is a daily freezing and thawing of the soil which mechanically pulverises the clay and renders it more pliable in spring, besides destroying insect pests

lurking therein. In spring the ridges have to be levelled and then a good surface tilth is ensured.

Digging, ridging, or trenching should be done in good weather only. It is advisable, moreover, to get these operations done in early autumn. The surface should also be left as rough as possible so that frost and air can easily penetrate and pulverise it. In spring and in summer frequent hoeing should be practised. This prevents the growth of weeds and the evaporation of moisture by repeatedly severing the capillary tubes.

Manuring the Soil.

Directly associated with the foregoing operations is the efficient manuring of the soil. Manure serves the twofold purpose of mechanically improving the texture of the soil and providing plant food. In the first place, it helps to make a heavy soil more light and pliable, and a light one more compact and retentive of moisture. It also supplies a substance called humus, which is essential for the sustenance of those wonderful organisms called bacteria. Then manure likewise provides the three main elements of plant food, namely, nitrogen, phosphates, and potash.

Take a heavy soil for example. Here we find that the best manures to use in order to improve it mechanically and chemically are horse or farm-yard dung, road grit, burnt refuse, decayed leaves, and lime. These should be applied at the time of trenching, digging, or ridging, and be thoroughly incorporated with the soil. Next take a light soil. Here we need to use materials to produce an opposite condition. Horse manure, grit, and refuse would render such a soil too light. What is needed is a material that will bind the soil particles together, retain moisture, and keep the earth cool in the summer. Long experience has proved that cow or pig manure is the best medium for this purpose. If to this clay or marl can also be added so much the better. Lime, again, is beneficial as it helps to bind the soil particles together, besides doing good in various other ways.

The best time to manure the heavy soils is in autumn or winter, and light soils early in spring. If we manured the latter in autumn the winter rains, which readily pass through the pores, would dissolve and wash away into the drainage all the solvent parts of the manure.

Now a word as to chemical manures. There are misguided persons who imagine that by using these alone they can dispense with animal manures. It should be clearly understood that chemical manures only supply plant food. They do not add humus or mechanically improve the soil. To use them alone for some time would not give such good results as if employed in conjunction with animal dung.

The next question is to advise the best kinds to use in conjunction with animal manures. Well, to supply phosphates, basic slag is best for heavy damp soils that contain little lime. Apply in autumn at the rate of 7 lb. per square rod. For light soils superphosphate at the rate of $1\frac{1}{2}$ to 3 lb. per square rod, applied in spring, is especially suitable. Bone-meal and dissolved bones may be used in either case in autumn, the former at the rate of 8 lb. and the latter at the rate of 4 lb. per square rod. To supply potash, kainit is a cheap and good form of this element, and it should always be supplied in autumn at the rate of 1 to 2 lb. per square rod. Sulphate of potash is also good, but dearer than kainit. Apply at the rate of 2 lb. per square rod in spring. Clay soils usually abound in potash, and only need an occasional lining to liberate the natural supply. Light soils are deficient in this element, and hence potash should always be

applied to them. As regards nitrogen, sulphate of ammonia is suitable for heavy soils and nitrate of soda for light ones. Both should be applied to growing crops only in spring or summer at the rate of 1 lb. per square rod.

Other manures which may be used freely are wood-ashes, burnt refuse, seaweed, blood, sewage, poultry dung, night-soil, liquid drainings from manure heap, soot, lime, and gas-lime. Guano is also a splendid fertiliser, for use during the growing season. Composts of seaweed, decayed leaves, weeds, burnt refuse, wood-ashes, night-soil, and a little lime make a splendid manure for garden crops, as this mixture contains potash, phosphates, and nitrogen, the three essentials for plant food, besides the means of mechanically improving the texture of the soil.

Gas-lime is beneficial for destroying soil pests as well as enriching the soil. It should be applied in a fresh state to vacant land only in autumn, and allowed to remain on the surface till spring, then be dug in. In its fresh state it is poisonous, hence its efficacy in destroying pests. But after long exposure it loses its poisonous property, and becomes a plant food. Lime, again, is beneficial if applied every three or four years. It sweetens sour soils, helps to kill pests, and sets free latent food in the soil. Apply gas-lime at the rate of 1 to 2 bushels, and ordinary lime at the rate of 3 bushels per square rod.

The Flower Garden.

Having so far dealt with the laying out of the garden, the proper treatment and manuring of the soil, we have, so to speak, laid the foundation for dealing with the culture of the crops to be grown therein. Here, again, the exigencies of space will not permit us to give extended details anent each subject.

For the decoration of the flower garden we have quite a wealth of beautiful vegetation. We have, for example, the charming varieties of the rose, hardy annuals, biennials, perennials and bulbs, and tender kinds like the dahlia, marigold, zinnia and so on, in addition to the pretty trees already briefly alluded to.

We have no fairer or more beautiful flower than the rose to decorate our gardens. We can grow it in beds or borders, on arches or pergolas, as hedges or for draping walls or fences. The rose likes a rich soil, not too light or heavy, deeply dug and well manured. A light soil should have clay added to it, and a heavy one plenty of grit. The best time to plant is in October or November, or in March, and the roots should be covered with about 6 inches of soil. There are standard, half-standard, dwarf, weeping, and climbing types of plants. Standards and half-standards require to be planted 3 feet, dwarfs 18 inches, weeping kinds 6 to 10 feet, climbers 6 to 8 feet apart. Pruning is best done in March or early in April. Climbers only need to have the weak or old growths thinned out and the tips of the last year's shoots cut off. The China, moss, and cabbage types should have weak growths thinned out, and the remaining shoots shortened half their length. Teas have weak growths thinned out, and the other shoots shortened to 6, 8, or 12 inches according to vigour; hybrid teas and hybrid perpetuals shortened to 8 or 10 inches according to vigour, and weak growths removed. Austrian briars, hybrid sweet-briars, and Japanese kinds merely want weak wood cut out; and noisettes shortened to 2 or 3 feet, and weak growths removed. Roses budded on the briar stock do best on the heavy soils, and those on the manetti on light soils. They may be increased by cuttings inserted

outdoors in autumn, budding in July; or grafting in heat in spring. Space will not permit us to mention varieties, but, generally speaking, the teas, hybrid teas, Chinas, and polyanth uses afford a great variety of delicate tints and pleasing fragrance; while for hedges, the hybrid sweet-briars and Japanese roses cannot be excelled. As climbers, the rambler type, of which crimson rambler and Dorothy Perkins are good examples, cannot be equalled for beauty of colour and brilliant effect.

Then in the way of other hardy flowers for garden decoration the hardy herbaceous perennials stand out pre-eminent for grace and beauty. In spring we have coloured primroses, polyanthuses, wallflowers, doronicums, hepaticas, gentians, aubrietias, arabis, and pæonies; in summer, single and double pyrethums, irises, lupins, delphiniums, heleniums, eryngiums, carnations, pinks, poppies, potentillas, antirrhinums, pansies, violas, and columbines; in autumn Japanese anemones, kniphofias, or tritomas, Michaelmas daisies, early flowering chrysanthemums, and perennial sun-flowers; and in winter the Christmas rose, as showy plants to make our gardens attractive at little cost and trouble. With the exception of the early flowering chrysanthemum, which is best reared from cuttings annually and placed out in May, the viola which succeeds best from cuttings struck in cold frames in autumn and planted out in spring, and the carnation increased by layers in summer, wintered in cold frames and planted out in spring, all the rest may be planted in autumn or spring, allowed to grow undisturbed for three years, then be divided and replanted in fresh dug and manured soil. The pæony and Christmas rose are exceptions to this rule; they are best left undisturbed. Beyond an annual mulching of decayed manure in autumn, and a light loosening of the surface in spring, they need no special culture.

Hardy bulbs, again, are exceedingly pretty and showy plants for the flower garden. In addition to growing them in the manner suggested in the opening part of this article, they may be grown in groups in the flower borders between the herbaceous perennials, or in beds. For spring flowering, snowdrops, crocuses, chionodoxas, scillas, narcissi, muscaris, hyacinths, early and cottage tulips, fritillarias, and tritelias; for summer, English and Spanish irises, *Lilium croceum*, *candidum*, *tigrinum*, *elegans*, *auratum*, and *speciosum*, tritonias, tigridias, ixias, and sparaxis; while for autumn, gladioli, colchicums, galtonias, and autumn blooming crocuses yield a diversified display of gay blossoms. Except gladioli, galtonias, and tigridias, which are best planted in March, the rest require to be planted in autumn. Plant the small bulbs 3 inches deep; the others 5 to 6 inches deep. It is not necessary to lift the majority of the bulbs unless grown in beds. In this case replant them elsewhere to complete their growth. Gladioli and trigridias should be lifted in November, dried and stored away, replanting in spring. We may point out that it is very undesirable to plant bulbs in lines or rows. They never have such a pleasing effect grown thus as in bold irregular groups. Another point, too; do not add manure to soil in which bulbs are to be grown. Bulbs like a rich soil that has been manured a year prior to planting.

Another section of hardy flowers that should be grown in the mixed border with perennials and bulbs are hardy annuals and biennials. They are showy and easily grown, and come in very handy for filling up odd corners. The most beautiful of the hardy annual section is the sweet pea. Varieties can be obtained of almost every conceivable tint, and apart from their attractiveness in the garden they are also invaluable for cutting.

To grow sweet peas well may require generous treatment. For yielding

flowers for cutting, the seeds may be sown in rows like culinary peas; but for flower-garden decoration they are best sown in circular groups or clumps. If to be grown in rows, trenches 2 feet wide and 2 feet deep should be prepared as follows:—Put 6 inches of rotten manure in the bottom and fork this into the subsoil, then filling the remaining space to within 2 inches of the top with a mixture of two parts of soil and one part of rotten manure. To every lineal yard of trench add a handful each of kainit and superphosphate and lightly fork this in. If to be grown in groups, dig out holes 2 feet wide and 2 feet deep, and add manure as recommended for the trenches. The same quantities of artificials should also be added to each hole. In March sow five seeds in a 3-inch pot filled with good soil, and place in a cold frame. When the seedlings are 3 inches high, carefully separate and plant them 8 inches apart in the trench, or four in each hole. Excellent results may, however, be obtained by sowing the seeds direct into the soil in March. Sow about eight seeds at equal distances apart, and 1 inch deep in each hole, and thin the seedlings out to five in each, when 2 or 3 inches high. In the trenches sow the seeds 3 inches apart. Stake the plants early and when the shoots reach the top of the stakes nip off their points. When flower-buds form apply a solution of sulphate of ammonia (½ oz. to a gallon of water) once a week. Give 3 gallons to each group, or the same amount to each lineal yard of the row. Keep all spent flowers picked off, and allow no seed pods to form.

Other showy hardy annuals worth growing in patches in borders, sowing the seeds thinly in March or April, are the yellow, white and purple sweet sultans, cornflowers, clarkias, sweet alyssum, candytuft, coreopsis, godetias, eschscholtzias, collinsias, *Linum grandiflorum*, nasturtiums, nemophilas, Shirley and carnation poppies, everlasting flowers and mignonette. Many of these will be useful for cutting. Sow thinly, and thin out the seedlings early to 3, 6, or 12 inches apart, according to their vigour, then they will make a sturdy growth and flower freely.

Biennials are plants that have to be reared from seed one year to flower the next, after which they die. Good examples are the Canterbury bell, sweetwilliam, foxglove, honesty, and *Verbascum olympicum*. Sow seeds of these outdoors in spring, transplant the seedlings 6 inches apart in early summer, and in autumn transfer them to the borders. Wallflowers, forget-me-nots, and antirrhinums are often treated as biennials, the plants being discarded after flowering.

Another section of garden flowers are tender annuals and perennials raised in heat and planted out in the garden in May and June for summer flowering. These, of course, can only be grown by those who possess heated glass structures. The tender annuals include such kinds as the China aster, ten-week stock, Japanese pinks, cosmos, lobelia, *Nicotiana affinis* and *sanderæ*, salpiglossis, Mexican, French, and African marigolds, zinnia, and *Scabiosa atropurpurea*. Seeds have to be sown in heat or on a hotbed early in March, the seedlings transplanted into pots or boxes and grown on in heat till May, then hardened off and planted out at the end of May. Stocks, asters, marigolds, Japanese pinks, and zinnias require a rich soil to grow well, hence it is desirable, before planting, to fork in plenty of well-decayed manure. The soil must also be kept moist in the summer.

The tender perennials embrace the following plants:—Dahlias, zonal pelargoniums (wrongly called geraniums), petunias, verbenas, ageratums,

begonias, calceolarias, cannas, gaillardias, gazanias, heliotrope, marvel of Peru, fuchsias, and marguerites.

Dahlias are exceedingly showy plants, especially attractive, being the Cactus varieties with spiky petals. The show, fancy, decorative, and pompon types are also good, but they by no means equal in charm or beauty the first-named type. Dig out holes for each plant 2 feet wide and 1 foot deep, put in 6 inches of rotten manure and fork this into the subsoil. Over this put 6 inches of good soil. Make the holes 4 feet apart. In June put one plant in each hole and leave a saucer-like depression around each plant. As soon as side shoots form select the four best and remove the others. Later on a flower-bud will develop on the main central shoot; remove this and then three new side shoots will form. These seven shoots only should be permitted to grow. When the side growths are well advanced it will be necessary to loop them to the stake to prevent them being broken by the wind. As soon as flower-buds form feed regularly once or twice a week with liquid manure. In autumn when the first frost has blackened the foliage, lift the tubers, cut off the stems, and place them stalks downward, to enable the sap to drain away. When dry, store the tubers in any cool, frost-proof place. Do not bury them in soil or ashes. In spring place them in pots or boxes in gentle heat to grow, and when the shoots are 3 inches long cut them off close to the tuber, and plant in pots of sandy soil in heat to root. These young cuttings will, when hardened off and planted out, yield finer flowers than old tubers. The latter may, however, be hardened off and planted out in May, if desired. In order to get good flowers it will be necessary in the latter case to thin the shoots freely.

Zonal pelargoniums require to be propagated by cuttings in autumn, wintered in heated greenhouses, placed in larger pots in spring, hardened off in May, and planted out in June. They flower best in soil not too freely manured. The silver, golden, and tricolour-leaved are more tender than the green-leaved kinds.

Petunias, ageratums, and verbenas may be raised from seeds sown in heat in spring, or from cuttings taken from old plants early in the year. The former plan is the simplest, and you get a greater variety of colours. Choice kinds of one colour are, however, best increased by cuttings. Heliotropes are more preferably reared from cuttings in heat in spring. Tuberous begonias may be raised from seed sown in heat, or from year-old tubers specially bought for the purpose. Gaillardias, again, are easily raised from seed in heat, and special varieties by cuttings in cold frames in autumn. Cannas are propagated by seed in a temperature of 75 degrees to 85 degrees, and they take a year at least to make good plants. Calceolarias are usually increased by cuttings inserted in sandy soil in a cold frame in October, and marguerites may be reared in a similar manner. Marvel of Peru may be reared from seed in the first instance. At the end of the season the tuberous roots may be lifted and stored like dahlias. Gazanias and fuchsias are increased by cuttings, the former in autumn like calceolarias, and the latter, in heat, in spring.

In growing the foregoing plants bear in mind that all with the exception of calceolarias, begonias, and fuchsias, which do best in the shade, need sunshine. Plant out at the end of May or early in June. Verbenas require their shoots to be pegged to the surface of the soil.

In addition to the foregoing there are also a few plants of climbing habit which are useful for trailing over vases, rambling over root stumps, and covering trellises or arches. These are the tall nasturtium, canary

creeper, tall convolvulus, Japanese hop, *Eccremocarpus scaber*, and *Cobœa scandens.* The first three are quite hardy, and the seed may be sown in the open ground in April. The other two are tender plants, and hence best reared in the heat, and the seedlings planted out in May. In warm districts the eccremocarpus will live outdoors for several years and produce its pretty orange-red flowers freely.

As regards permanent climbers for clothing walls, fences, arbours, and tree stems, there is a great variety. For a north wall ivies and the Virginian creeper are the most suitable kinds. For an east wall the evergreen firethorn (*Cratægus Lelandii*), which bears red berries in winter, *Vitis inconstans* (better known as *Ampelopsis Veitchii*), and the honeysuckle are good kinds. For a west wall *Clematis Jackmanii* and Lady Nevill, white jasmine, and variegated ivies; while for a south aspect *Passiflora cœrulea, Jasminum nudiflorum, Clematis montana,* Wistaria, and *Tecoma radicans* are well suited. To cover arches, trellises, or pergolas, any of the foregoing, with the addition of *Polygonum baldschuanicum* and *Aristolochia sipho,* may be used. We must not omit to mention the brilliant scarlet-flowered *Tropæolum speciosum*, which thrives so happily in Scotland and other cool, moist districts. This creeper will succeed in any cool, moist position, such as the north side of a hedge or wall. It does best in a mixture of leaf-mould and peat. It has a charming effect in summer when its flower-decked shoots are rambling over a hedge.

Greenhouses and Frames.

According to Cowper, he

> "Who loves a garden
> Loves a greenhouse too."

As, nowadays, few gardens exist without a greenhouse or frame, we must find room in this article for a few words on this subject. There are two types of greenhouse, the cold or unheated and the heated. The former is not so serviceable as the latter, because it cannot be utilised so profitably in winter. In spring, however, it comes in useful for rearing tender plants from seed, and, in summer, for growing a crop of tomatoes, or a few flowering plants. In autumn, too, it may be used to shelter chrysanthemums grown in pots outdoors during the summer. Many enthusiasts contrive to make good use of such a structure in winter and spring by growing bulbs in pots such as — snowdrops, *Iris reticulata,* crocuses, narcissi, tulips, and hyacinths. These need no artificial warmth, and will flower much earlier than if grown outdoors. Then auriculas may also be grown and flowered therein in spring.

A heated house (temperature 45 degrees to 55 degrees) is, however, much more serviceable. It can be used all the year round. In winter, for example, it is possible to have Chinese primulas, cyclamen, azaleas, calla lilies, tree carnations, and forced bulbs in flower; in spring, bulbs, *Cytisus fragrans,* deutzias, lilacs, cinerarias, acacias, boronias, and roses; in summer, fuchsias, tuberous-rooted begonias, hydrangeas, lilies, heliotropes, pelargoniums, etc.; and, in autumn, vallotas, chrysanthemums, tree carnations, bouvardias, and so on. With a few ferns, palms, and other foliage plants such a house could be made a dream of perpetual beauty. If space permits to grow a Maréchal Niel rose and such climbers as *Plumbago capensis, Clianthus puniceus,* and a *Cobœa scandens* on the roof, the charm of the house will be still further enhanced.

Some people prefer to specialise and grow cool or intermediate orchids; others cacti and succulent plants; others again the new type of American winter-flowering carnation, or the exhibition kinds of chrysanthemums. In this way a good deal of pleasure is obtained.

Those of a more utilitarian turn of mind use a heated greenhouse for propagating plants in spring; growing tomatoes, cucumbers, and melons in summer; mushrooms in autumn; and forcing early rhubarb and seakale in winter.

Seeing the great advantage of having artificial heat and bearing in mind that heating apparatus can be obtained at a low cost for structures of all sizes, the question naturally arises as to whether it is really worth while to have a cold greenhouse. Oil stoves may be obtained for heating the smaller types of houses, and they answer well for keeping out frost, if kept clean and properly trimmed. Far better, however, is a hot water apparatus heated by oil, gas, or ordinary fuel. Hot water emits a more congenial heat than hot air; the latter dries the air too much. If oil be used, an exhaust pipe should be attached to carry off the fumes, and great care must be taken to trim the wicks and keep the lamp quite clean. There is always the risk of the flame flaring up, filling the house with black smoke, and damaging the plants. Gas is far preferable to oil for small apparatus. It is cleaner, safer, and in every way better. For houses from 12 feet by 8 feet upwards apparatus heated by coke or coal is cheaper and better than gas. Quite a variety of slow combustion boilers are in the market which need little attention, and burn only a moderate amount of fuel. The silver medal horse-shoe is one of the best of this type. Some day electricity may be utilised to provide the needful heat. At present the idea is only in the experimental stage of development.

So far as the management of a greenhouse is concerned, the requirements are simple. Plants, like man, require pure air, therefore attention must be paid to the proper ventilation of the structure. A stuffy, stagnant air is injurious to plants. In winter the ventilators should be open a little during the morning. In spring as the sun increases in power gradually give more air, and for a longer period during the day. In summer, air must be supplied in abundance by day, and moderately by night. In autumn gradually reduce the supply and adopt the rule advised for winter. Never open the ventilators in the direction in which the cold winds are blowing; open them on the lea side. Cold winds chill the delicate tissues of plants, and in time bring them into ill-health.

Watering, too, is another important detail of greenhouse management. In winter use tepid water only, and give just sufficient to fill the space in the pot; do not spill any on the staging or the floor. Rap each pot with a stick; if a dull sound results, no water is required; if a clear sound is produced, water is needed. In spring and summer water will be more copiously required, ofttimes twice daily. In autumn less will be in request. Plants at rest do not require water.

During the latter parts of spring and in summer, shade will be necessary during the hottest part of the day. Some gardeners paint the glass with an opaque substance, but a movable blind is infinitely better because it makes it easily possible to give the plants the full benefit of light when the sun is not shining.

In severe weather it is not advisable to try to maintain a high temperature. Too much artificial heat has a tendency to weaken the growth of the plants. It is better on severe frosty days and nights to cover the sides of the greenhouse with mats to prevent the frigid ex-

ternal air from chilling the glass and neutralising and wasting the internal heat.

Lastly, keep the exteriors of the pots frequently washed to prevent slime and moss filling the pores and excluding fresh air to the soil. Once a year, too, have the woodwork and glass thoroughly coated with lime-wash and sulphur. And above all things see that pests and fungi get no secure foothold on the plants.

A word or so about frames. Cold frames are useful adjuncts to the garden. In the autumn and winter they are valuable for striking cuttings and wintering them, also for storing spring bulbs in pots till they are required for the greenhouse. In the spring they can be used for rearing half-hardy annuals from seed and hardening off bedding plants. Or they may be placed on a hotbed of manure and used for rearing tender plants, growing early crops of radishes, potatoes, or carrots or cucumbers. In summer they come in useful for growing seedling primulas and cinerarias for flowering later on in the greenhouse.

The Kitchen Garden.

So far we have confined our remarks to the decorative features of the garden. To most readers of this work, however, it is more than probable that the utilitarian phase of gardening will appeal the most strongly. In every country home the kitchen garden and the orchard are at any rate the predominant features, flower-growing occupying a secondary position. To be able to grow a good supply of vegetables all the year round is a matter of considerable importance, and we must therefore deal with this subject in a more exhaustive manner than we have the other features of the garden.

Before we actually deal with the culture of the various crops, we desire to say a few preliminary words. First, with reference to the soil. The ideal soil for a kitchen garden is a deep sandy loam or, at any rate, a fairly deep and rich soil. Heavy clays or boggy or peaty soils are the worst of all in which to grow vegetables. A deep tilth, too, obtained by periodical trenching, is most essential. Earlier in this article we described the best methods of treatment for soils of all kinds, and the reader must carry out the advice there given if he desire to ensure good crops.

As regards the site for a kitchen, the ideal spot is a plot having a gentle slope from north to south, or north-west to south-east. The site, moreover, should not be in a valley, but fairly well elevated so as to be above the frost line. The most undesirable positions are those sloping south to north or west to east. Shelter from north and north-east winds is also desirable, and where a wall 12 feet to 14 feet high cannot be built on these sides, then plant a thick belt of Scotch firs, Norway spruce, and Austrian pine, mingled with ash, birch, beech, and poplar, for the purpose eventually of forming a good screen. Where a kitchen garden can be surrounded by a wall 12 feet to 14 feet at the north end, east and west sides by a wall 10 feet high, and the south by a wall 6 feet to 8 feet, an excellent shelter will be obtained, and the wall space can be turned to profitable account for the growth of fruit trees.

A kitchen garden should be laid out as simply as possible. Thus, all round the margin of the boundaries, borders 10 feet to 16 feet wide should be provided; next these a path 4 feet to 6 feet wide; a path of similar width down the centre, and one of similar dimensions across the middle. This provides four central or main plots for the growth of the principal plots, and a border all round for growing herbs, saladings, and early crops.

The foregoing remarks apply to the orthodox style of kitchen garden. Excellent crops of vegetables may, of course, be grown on open plots of land, provided there be shelter from north and north-east winds, and the land be not overshadowed by the branches, or overrun by the roots of trees. Of course, it is not possible to get crops so early in the latter case as in gardens protected by walls.

If the site be at all damp it is most imperative that it should be well drained. Seeds will not germinate satisfactorily nor crops thrive well in water-logged soil. Deep trenching will do much to get rid of superfluous surface water, but it will be wise, nevertheless, to drain the land as an extra precaution.

To ensure a succession of vegetables a definite system of cropping must be pursued. Let us take the four main plots of the kitchen garden to illustrate what we mean by the rotation of crops. One of these plots we advise to be set apart for such permanent crops as—rhubarb, seakale, asparagus, horseradish, and herbs. This leaves us three plots on which to grow the temporary or annual crops. The first year we recommend No. 1 plot to be devoted to beet, carrots, parsnips, celery, leeks, and potatoes; No. 2 plot to beans, peas, onions, turnips, spinach, and lettuce; No. 3 plot to cabbage, kale, broccoli, savoys, and Brussels sprouts. The second year plant No. 1 plot with beans, peas, onions, turnips, and lettuce; No. 2 plot with cabbage, savoys, Brussels sprouts, kale, cauliflower, and broccoli; and No. 3 with potatoes, carrots, leeks, celery, and parsnips. The third year No. 1 plot should be devoted to cabbage, savoys, Brussels sprouts, kale, cauliflower, and broccoli; No. 2 plot to potatoes, carrots, beet, parsnips, leeks, and celery; and No. 3 plot to peas, beans, spinach, onions, and turnips. This simple method of cropping provides for each plot growing the same kind of crop only once in three years.

Moreover, as it is indispensable that such deep-rooting crops as beet, carrots, and parsnips should have a good depth of soil, the plot for this crop must be trenched the previous autumn, and thus all the plots get trenched in rotation. We advise either a plan or rough sketch to be made in a book and the rotations marked therein for future guidance. There is another point, too, which must not be overlooked. As root crops do not require farmyard manure, it is only needful to manure the plots for the peas and the cabbage crops annually. This uniform system economises the manure, as each succeeding crop takes out of the soil that portion which its predecessor does not require, and there is, consequently, no waste of food.

In addition to this excellent plan of growing vegetable crops there is another method worthy of note here, and that is making the best use of space by the growth of what are known as "catch crops." Thus the thrifty and intelligent gardener usually prepares his celery trenches in the spring, and early in May either sows a row of French beans or lettuce along the top of each ridge of soil between the trenches; or he marks out early in the year the lines of his late celery trenches and sows early peas thereon; forms the bed for vegetable marrows early, and sows radishes on the surface; drops a seed of broad bean at intervals of 2 feet in the rows of early potatoes; scatters seed of lettuce or radishes on his newly made asparagus bed; or sows a row of spinach between every two rows of early peas, and so on. Again, where space is very limited, one crop may follow another in quick succession, as strawberries or cabbage to follow early potatoes; autumn-sown onions, early peas; and kale, broccoli, and Brussels sprouts between the rows of early potatoes.

An important point to observe in vegetable culture is not to plant any of the cabbage tribe in succession to each other on the same plot under a less interval than three years; nor to grow carrots, beet, and parsnips in succession; nor onions, leeks, and shallots for a similar reason. By cropping as previously advised this mistake will not occur.

In the matter of seeds never sow old ones if you can avoid it. While it is true that many seeds will retain their vegetative powers for several years, and it may seem a wasteful thing to throw them away, yet experience has shown that the produce therefrom is never so satisfactory as that from new seeds. Old seeds give birth to a weakly progeny; new ones possess all the stamina and vigour for yielding strong, healthy plants, and are well worth the annual cost of replenishing. Do not be tempted to buy cheap seeds either; they will in the end prove dearer than the more expensive and carefully selected ones. Avoid also the mistake of sowing them too deeply or too thickly. Buy good seeds and sow thinly in well-tilled soil, and far better crops in every way will follow. Never sow seeds when the soil is very wet or the weather cold. Seeds are tender, and their delicate organisms are easily destroyed or crippled by lying in the cold wet earth. Choose fine weather for sowing, and then the seeds will speedily germinate and produce strong plants.

Nor ought seedlings to remain too long before thinning out or transplanting. Onions, carrots, parsnips, and similar crops should be thinned out as soon as they can be easily handled. This prevents loss of food to the remaining plants, and gives them plenty of light and air to develop. Carrots, beet, and parsnips soon get their roots twisted and ill-shaped if allowed to grow thickly together. In the case of cabbage, kale, and allied plants, it is most important that the number of plants required for future planting be lifted and transplanted 6 inches apart each way in a nursery bed, directly their third leaf has formed. The lifting breaks off the tap-root, and the removal to fresh soil encourages the seedlings to make a mass of fibrous roots. When planted out finally the plants show a healthy, sturdy growth, and there is no risk of "bolting" occurring as in the case of seedlings left in the seed-bed till finally planted out.

Tap and Bulbous-rooted Crops.

Under this heading we shall deal with beet, carrots, parsnips, turnips, salsafy, scorzonera, onions, shallots, garlic, leeks, and celeriac. These have either tap or bulbous roots.

Beet is a much appreciated salad vegetable, which has been cultivated more or less continuously in Britain since 1548, and was well known to the ancient Greeks and Romans. It requires a sandy or loamy soil free from stones, heavy soils not suiting it. No manure should be added to the soil except 2 oz. of superphosphate and 1 oz. of sulphate of ammonia per square yard, before sowing. On light sandy soils 3 oz. of salt per square yard may be applied a week before sowing. The best time to sow is early in May. Draw drills 1½ to 2 inches deep and 12 to 15 inches apart, and drop the seeds in groups of three or so at intervals of 8 inches along the row. When the seedlings are well up reduce these to one in each place. This plan economises seed and labour in thinning, and there is no risk of overcrowding. It is a good plan to soak the seeds in water for six hours before sowing. Hoe between the rows frequently to keep down weeds and aerate the soil. Lift the roots early in November, by thrusting a fork or spade to its full depth in the middle of the row, then

pressing the handle back with one hand and seizing the foliage with the other. The root will then easily come out without breaking its tap-root. Twist off the leaves. Store the roots in layers with soil or sand between in a cool frost-proof place. Long-rooted kinds are best for deep sandy soils, and the turnip-rooted for shallow or heavy soils.

Carrots are said to have been first introduced into Britain by the Flemings in 1588, and according to Pliny they were grown by the Romans. There are three types of this vegetable—the shorthorn, much grown for forcing early; and the intermediate and long, both maincrop kinds.

The shorthorn kinds do best in a light rich soil; the others in a deep well-tilled sandy loam. Stony soils cause ill-shaped roots to form. No stable manure must be used for this crop. In autumn, however, 1 lb. of kainit per square rod may be dug in, and in the spring, just before sowing, 2 lb. of superphosphate per square rod may be added. After the seedlings are thinned apply 1 lb. of nitrite of soda or 1 peck of soot per square rod. Sow shorthorn carrots in January, February, and March, in each case on a south border; and the intermediate and long kinds in March or April. The drills should in each case be 1 inch deep; 6 inches wide for the shorthorns, 12 inches for the intermediate, and 15 inches for the long kinds. Mix the seed with sand to cause it to separate easily, and sow very thinly along the drills, and then cover with fine soil. Thin the shorthorns to 3 or 4 inches, the intermediate to 6 inches, and the long kinds to 8 inches apart. Hoe frequently during the summer. Early in November lift the crop, cut off the tops, and store the roots as advised for beet, or place them in a conical heap outdoors, cover with a layer of straw, and finally with a 6-inch layer of soil dug out of a trench round the base of the heap. Insert a wisp of straw in the crown of the heap to serve as a ventilator. Carrots reach maturity in twenty to twenty-four weeks after sowing. Those who possess a cold frame and plenty of manure can make a hotbed in February or March, cover the manure with 6 inches of fine soil, and sow seeds of the shorthorn kinds to obtain a supply of young carrots in May. Radishes may be sown with the carrots, the former crop maturing in about seven weeks and being cleared off before the carrots need the extra room.

Parsnips have been grown in Britain from the earliest period, and were also extensively cultivated by the Romans. They are an excellent winter vegetable, in fact are in their best condition after they have been subjected to a few winter frosts. A deep sandy soil yields the finest roots, but they will also do well on heavy soils. A deep tilth is essential. No stable manure must be added to the soil, but 1 lb. of kainit per square rod may be trenched in during autumn, and 2 lb. of superphosphate and 1 lb. of sulphate of ammonia applied in spring before sowing. In February, or early in March, draw drills 1½ inch deep and 15 inches apart, and drop the seeds in groups of three or so a foot apart. When the seedlings are 3 inches high reduce their number to one in each group. Beyond an occasional hoeing, no further culture will be required. In November the crop may be lifted and stored like carrots, but the roots will be of better flavour if left in the ground and lifted as required. To get extra fine roots on heavy soil bore holes 4 feet deep and 6 inches wide at the top with a crowbar. These holes should be 18 inches apart in the row, and 2 feet from row to row. Fill the holes with a compost of finely sifted decayed refuse, road scrapings, old potting soil, and wood ashes. In each hole put a pinch of kainit and superphosphate. Sow three seeds in each hole, and press them in an inch deep. Thin out the seedlings to one in each hole, and then by the following November roots upwards of 4 feet long and 6

inches at the crown will be the result. Parsnips mature in twenty-four to twenty-seven weeks after sowing the seeds.

Salsafy, sometimes called the "vegetable oyster," is more largely grown on the Continent than in Great Britain. Its roots are rather sweet in flavour, and are not generally appreciated. The soil must be deeply dug and manured as advised for carrots. Sow the seeds in groups of three, 10 inches apart in drills 1 inch deep and 1 foot apart, about the middle of April. Hoe between the rows in summer and remove all flower stems that form. Lift the roots early in November, and store as advised for beet. The crop takes about eighteen weeks to arrive at maturity.

Scorzonera is a tap-rooted vegetable of Spanish origin, and was first introduced into Britain in 1576. Like salsafy, its roots have to be scraped, then thrown into water with a little lemon-juice, boiled for half an hour in water containing salt, lemon-juice, and butter, and afterwards served with cream on toast. Its cultural requirements are precisely as advised for salsafy.

Onions have been cultivated from time immemorial. They were a favourite vegetable with the Israelites, as Holy Writ testifies, and the Ancient Greeks and Romans also held them in high esteem. In a young state they are much in request for salading, and in their mature condition for pickling, boiling, and roasting. The onion requires a soil neither too light nor too heavy, and it must be rich. A light soil must be well enriched with cow or pig dung, and heavy soils improved by adding wood ashes, decayed manure, and road scrapings. The soil should be manured and dug deeply in winter, adding at the same time 1 lb. of kainit per square rod. In February apply fresh lime at the rate of 3 bushels per square rod, and just before sowing, 1 lb. of superphosphate per square rod, with a similar amount of nitrate of soda after thinning. As a preventative of the onion maggot, mix equal quantities of soot and salt together and apply 2 lb. per square rod a week before sowing. Make the surface soil fine and firm. Draw drills about ¼ inch and 8 inches apart. In March sow the seed thinly, cover with fine soil, then lightly roll or tread the surface. Thin the seedlings out in May or June to 3 inches apart if medium-sized bulbs are desired, or 6 inches apart for a larger size. Hoe the soil frequently. Seeds may be sown in heat in January or February, the seedlings being transplanted into boxes, hardened off in April, and then planted out. This plan is only necessary when very large bulbs are desired. Early in August bend over the tops, and towards the end of the month pull up the bulbs, lay them out on a dry path for a week thoroughly to get dry, then store away in a cool, dry, airy place. Onions may also be sown in August in soil just cleared of early peas or potatoes. In spring these can be thinned out, and the thinnings replanted in rich soil to make fine bulbs for autumn use. The Tripoli onion is a good kind to sow in August. For spring saladings sow the white Lisbon in August. The onion crop reaches maturity in about twenty-four weeks after sowing. The potato and the tree onion may be regarded more as curiosities than as vegetables of real practical value.

Shallots originally came from Ascalon in the Holy Land, and have been grown in Britain since 1548. They are much esteemed for pickling, and are also extensively employed for sauce-making. A light well-drained soil and sunny spot is required to grow shallots. Fresh manure should not be used, but 1 oz. of kainit and 2 oz. of superphosphate per square yard may be dug in prior to planting. Plant the bulbs 18 inches apart in rows 1 foot asunder, early in March. Press each bulb about half-way into the soil. About

the end of June remove the soil from the base of the bulbs, and early in August pull them up, dry them thoroughly in the sun before storing away. Shallots are easily reared from seed sown in drills a foot apart in March and thinning the seedlings out later to 6 inches asunder.

Garlic is not very largely grown. It requires a rich soil. Draw drills 3 inches deep and 1 foot apart early in March. Plant the cloves 6 inches apart and cover with soil; or plant whole bulbs as advised for shallots. Lift and store in July.

Leeks, like their savoury sister the onion, were known to the Israelites, and the famous Roman Emperor Nero is reputed to have "ate it (*i.e.* the leek) on several days in each month to clear his voice." Tusser, too, makes reference to the leek in his *Five Hundred Pointes of Good Husbandrie*, published in 1557, so that it must have grown in Britain for a long period. Any good ordinary soil, well enriched with plenty of rotten manure, will grow leeks well. Sow the seeds in March in drills 6 inches apart, and thin out early to 6 inches apart. There are two ways to grow them afterwards. One is to make holes a foot apart each way and 9 inches deep. In each plant a leek when a foot high. Drop the roots to the bottom of the hole and put in about ½ inch of soil, leaving the remaining space unfilled. During the summer liquid manure is occasionally poured into each hole, and by the following spring fairly good blanched stems are obtained. The other plan is to dig out trenches a foot wide and deep, put in 6 inches of rotten manure and 3 inches of soil on top. The plants are then put in 9 inches apart in a single row. By degrees the plants are gradually earthed up like celery, and fine stems are obtained. Those grown in the trenches should be fed frequently with the following solution: 1 oz. each of superphosphate, kainit, and nitrate of soda to a gallon of water. Some growers instead of earthing up with soil blanch the stems by wrapping brown paper round them. Where early crops are desired, sow under glass in February, harden off, and plant out in April. The crop reaches maturity in about thirty-six weeks after sowing.

Celeriac or turnip-rooted celery is a very hardy form of celery with a swollen stem, not unlike a turnip, and is eaten in a cooked state. Seeds have to be sown, in heat, in March, the seedlings transplanted into boxes, hardened off in a cold frame in April, and planted out in rich soil 18 inches apart each way in May or June. Keep well watered and remove all suckers that form at the base. In October lift, remove all outer leaves, and store in sand in a cool place until required for use.

Turnips were first introduced in this country from Holland in 1550. They require a light soil to do well. Heavy soils must be lightened by the introduction of plenty of decayed manure and grit in order to suit the turnip. To encourage a rapid growth and good, tender, well-flavoured roots dig in plenty of decayed manure, also add 3 bushels of lime per square rod in February, and 2½ lb. of superphosphate, 2 lb. of guano, ¼ lb. of sulphate of ammonia, and ½ lb. of kainit per square rod just before sowing. Wood-ashes should be freely added. Sowings should be made in February, March, and April, May, June, and July. Draw the drills 1 inch deep and 12 inches to 18 inches apart, according to the vigour of the variety. Sow thinly. As soon as the first rough leaf forms, thin out to 6 inches apart. Dustings of soot early in the morning will keep off the "fly." Hoe frequently. A portion of the July sowing may be left in the soil to yield "greens" or "tops" for spring use. The turnip reaches maturity eight weeks after sowing.

Peas and Beans.

The pea, and the broad, French, and runner bean, are very popular vegetables. No vegetables, indeed, can equal in delicacy of flavour the marrowfat varieties of the peas, and as for the French and the runner bean both are keen rivals of the pea.

Peas are supposed to have been first introduced into this country from France and Holland in the time of King Henry VIII. In Queen Elizabeth's reign they were considered as a dainty dish for ladies only, and it was not until after the restoration of King Charles II. that they were grown extensively. The Greeks and Romans were familiar with them. The pea originally came from Western Asia. To grow first-class peas the soil must be deeply tilled and well manured. On light soils a good layer of decayed manure should be placed under the first spit of soil in winter. Medium and heavy soils should also be well manured in autumn. In addition 1 lb. of kainit per square rod should be applied to light soils in autumn and 2 lb. of superphosphate per square rod in winter. Peas do not require nitrogenous manures as nitrate of soda, etc., as they have the power of collecting nitrogen by means of nodules on their roots. Peas are divided into four sections—early, second early, maincrop, and late. The early sorts are generally sown outdoors in January and February, or in pots or turfs, under glass, in January, and the seedlings afterwards planted in the open in March. Second early sorts are usually sown outdoors in February; maincrop kinds in March, April, and May; and late sorts late in May or early in June. Early sorts, too, are often sown in June to give late supplies. The drills for receiving the seeds should be drawn 6 inches wide and $2\frac{1}{2}$ inches to 3 inches deep. Flat drills are much better than the old V-shaped drills. As a result of sowing in the latter the seeds lie on one another and often rot instead of germinating, whereas by using a flat drill there is ample space made for the seeds. Varieties that grow from 1 foot to 2 feet high should be grown in drills 2 feet apart; those from 2 feet to 4 feet high in drills 3 feet apart; and those from 4 feet to 6 feet high in drills 6 feet to 8 feet apart. The seeds should be sown in two parallel rows thus— · · · · ·
 · · · · · ·
The round-seeded kinds should have their seeds placed 3 inches to 4 inches apart; the marrowfats 6 inches apart. The old idea of sowing the seeds thickly along the drill is a great mistake; it is not only a waste of seed, but there is insufficient room for the seedlings to develop. By sowing as above advised, each seedling has plenty of room, and when it is well above the soil, the stem will branch out, form a sturdy plant, and yield a finer and heavier crop of pods. Cover the seeds with soil, and when the seedlings are a few inches high, draw mould to each side and stake them in the usual way. When the plants reach the top of the stakes nip off their points; this will promote the branching of the stems and the setting of the pods. Copious supplies of water should be given in dry weather, and a thick mulch of manure placed on each side of the row to conserve the moisture. Liquid manure may also be given when the pods begin to form. The edible-podded, or sugar pea, a kind the pods of which as well as the seeds are cooked whole, is grown in the same manner. It may not be generally known that the young points of shoots, if boiled and strained through a sieve, make excellent pea-soup. Peas are usually ready to gather about fourteen to sixteen weeks after sowing.

French, or kidney beans, were first introduced into Great Britain

in 1509. There seems to be a doubt as to their native country, but as reference is made to them in the writings of Pliny (23 A.D. to 79 A.D.) it is probable that Asia is their native habitat. They require a warm, well-drained, and rich soil. Plenty of decayed manure should be dug into the soil in winter, and 1 lb. of kainit per square rod at the same time, also 2 lb. of superphosphate per square rod in spring, on light soils, or 7 lb. of basic slag in winter on those of a heavy nature. The first sowing should be made at the end of April, and successive ones in May, June, and July. Draw flat drills 6 inches wide and 3 inches deep and 3 feet apart. Sow in two rows thus—

. . . .
 . . . .

placing the seeds 8 inches apart. Draw mould up to each side of the row when the seedlings are a few inches high. In dry weather water freely and give occasional applications of liquid manure. Butter beans are grown in the same way. There are climbing varieties of the French beans. These require to be grown in rows 5 feet to 6 feet apart, and to have their growths supported by stakes. The crop is ready to gather fourteen weeks after sowing. The dwarf kinds may be forced in pots in heated structures, early in the year, if desired.

Runner beans are natives of South America, and were introduced into this country in 1633. The runner bean is strictly a perennial, and has tuberous roots which may be preserved and replanted, but the results are not satisfactory. It is better to rear the plants annually from seed. Any good garden soil as advised for kidney beans will suit the runner bean. Make the first sowing early in May and a second sowing at the end of the month. Draw drills 1 foot wide, 3 inches deep, and 8 feet to 12 feet apart. It is advisable that the rows should run from north to south. Sow the seeds 6 inches apart in a double row down the drill. On very light soils it is preferable to dig out a trench 1 foot deep and 2 feet wide, put in 6 inches of manure and 4 inches of soil on the top and then sow the seeds. The manure will keep the roots moist, and the shallow trench will be adapted for receiving any water applied. When the plants begin to send forth their runners, supply the usual stakes. As soon as the tops of the stakes are reached, nip off the points of the shoots. Where stakes are difficult to get, keep the ends of the shoots nipped off 2 feet from the ground and grow the plants as dwarfs. The crop will be ready to gather sixteen weeks after sowing.

Broad beans are natives of Egypt, and have been grown here from the earliest period. It is probable they were introduced by the Romans, who cultivated and esteemed this vegetable. The broad bean likes a heavy deep loam and plenty of manure, with the addition of the artificials advised for kidney beans. The early long pod varieties should be sown in January or February, and the broad or Windsor kinds in February, March, and April. Draw drills 6 inches wide, 3 inches deep, and 3 feet apart. Sow the seeds 6 inches apart in a double row in each drill. Steep the seeds overnight in water. Earth up the plants when 6 inches high, and nip off their tops when the blossoms form. The crop is ready to gather twenty weeks after sowing.

Tuberous-rooted Crops.

Potatoes are the chief vegetable under this heading, and are more extensively grown, indeed, than any other crop. The potato is a native of South America, and supposed to have been first introduced by Sir

Walter Raleigh. With the exception of heavy clay or peat, the potato will grow in most soils. Loamy or sandy soils, however, suit this crop best. A good dressing of stable dung should be dug in during autumn. In spring before planting apply 2 lb. of superphosphate and 1 lb. of sulphate of potash per square rod. When the shoots are 6 inches high, apply 1 lb. of nitrate of soda per square rod. The best size of "set" or tuber for planting is one averaging from $2\frac{1}{2}$ oz. to 3 oz. in weight. Larger or cut "sets" are not so satisfactory. The "sets" should be sprouted by placing the tubers on their narrow ends in rows in shallow boxes early in the year, and exposing these to the light. Allow only two strong shoots to form on each. Early sorts should be planted early in February, second early ones in March, and late kinds in April. The drills for the early sorts should be 20 inches, medium growers 30 inches, and strong ones 3 feet apart. A good average depth is 6 inches. The "sets" should be placed 8 inches apart for earlies, medium growers 12 inches, and strong ones 16 inches to 18 inches apart. In planting, place the tubers with their sprouts upwards. In the case of early sorts it is a good practice to cover each tuber with a handful or so of light mould. Well hoe the surface between the growing crop, and earth up when the shoots are 6 inches to 8 inches high. Lift the crop when the haulm turns yellow and the tubers have their skins fairly set. Tubers for eating should not be exposed long to the air or light. Store them quickly in clamps or cool dark places. Those intended for "sets" may be allowed to get green and then be stored in a light place, afterwards placing them in boxes as previously suggested.

Jerusalem artichokes are not everybody's favourite, but a few are worth growing in odd corners. They come from Brazil, and belong to the sunflower tribe. Plant the tubers 15 inches apart in drills 5 inches deep and 3 feet apart, in February. Lift in autumn as required. Any ordinary soil will suit.

Green Crops.

Under this heading we shall deal with cabbage, cauliflower, broccoli, borecole or kale, Brussels sprouts, and savoys.

Cabbage is a very old vegetable. It has been grown by the ancients, and in this country from the earliest period. Supplies may be had all the year round. Thus for spring use seeds have to be sown in July or early in August, and the plants placed in their permanent positions in September; for summer use, seeds have to be sown in March, and the crop planted out in May; for autumn use, sow seeds in April and plant out in June; and for winter use, sow early in May and plant out in July. The cabbage likes a rich soil, so dig in plenty of manure, adding 1 lb. of kainit and 1 lb. of superphosphate per square rod. When the plants have been established a month apply 1 lb. of nitrate of soda per square rod. Treat the seedlings as advised in the early part of this section. Plant small growers 1 foot apart, in rows 18 inches asunder; and strong growers 2 feet apart each way. In autumn a row of colewort cabbages may be placed between two rows of cabbages, and one colewort between each pair of cabbages, the coleworts being cut and used during winter. Red cabbages may be sown in March for planting out in May, or in August for planting out the following March. Colewort is usually sown in July or early in August.

Borecole, or kale, is a very hardy type of winter green, the Scotch kale perhaps, being the hardiest of all the varieties grown. It is really a form of the cabbage, and very easily grown. It will, moreover, grow in any

soil that is fairly rich, and there is no necessity to add manures specially for its growth. Borecole is usually planted on land cleared of peas, or between the rows of early potatoes. Sow the seed outdoors early in April, transplant the number of seedlings required 6 inches apart in a nursery bed, and in June plant out finally, 2 feet apart in rows 30 inches asunder. The crop is ready for use any time after November. In gathering the Scotch and purple kinds cut off the tops first, then side sprouts will form for future use.

Broccoli, no doubt, originally came from Italy. It is similar in character to cauliflower, differing only in its greater hardihood. There are autumn, winter, and spring varieties. For autumn use, sow outdoors early in April; for the winter crop, in mid-April; and for spring use, early in May. Sow the seeds thinly in drills 6 inches apart, and when the seedlings are well up, transplant them 6 inches apart in a nursery bed. Broccoli likes a firm rich soil. It is best, therefore, to plant on land recently cropped with peas. Fork in 1 lb. of superphosphate per square rod before planting. Plant the first batch out early in June, the second at the end of June, and the third early in July. The plants should be 24 inches apart in the rows, and the rows 30 inches asunder. A month after planting apply 1 lb. nitrate of soda per square rod. In winter it may be advisable to take out a spadeful of soil on the north side of each plant, bend the stem into this trench, and place the soil over the stem on the south side. This will shield the "hearts" from injury by frost, and is known as "heeling over."

Cauliflower, as previously explained, is not unlike broccoli in general form. It has, however, a more white and compact head, and is less hardy than the broccoli. On the latter account it requires a warm, well-drained, and moderately light soil, and sunny position to do well. The soil should be double-dug and have a good layer of well-rotted manure placed between the first and second spit. It will also be beneficial to add 1 lb. of kainit, 2 lb. of superphosphate, and 1 lb. of sulphate of soda per square rod at the time of digging. When the plants are established apply 1 lb. of nitrate of soda per square rod. Two crops a year are generally grown. For autumn use sow outdoors in April, transplant the seedlings 6 inches apart when their third leaf forms, and plant out 2 feet apart in rows 8 feet asunder, early in June. Sow again outdoors in September, and lift the seedlings when their third leaf forms, and replant them 6 inches apart in a cold frame. Keep them there till April, then plant out permanently for cutting in June. In a cold spring place a branch of evergreen shrub on the north side of each plant, or cover it with a "cloche" or bell glass to protect it from injury. When the hearts begin to form, snap a leaf over the heart to prevent it being browned by the sun.

Brussels sprouts originally came from Belgium, and are said to have developed from the savoy. We have no authentic record as to when they were first introduced into Britain. To ensure fine sprouts the soil should be liberally manured and deeply dug the autumn prior to planting. Add 1 lb. of superphosphate per square rod just before planting, and 1 lb. of nitrate of soda a month afterwards. Seeds may be sown, in heat, in March, the seedlings hardened off in April, and planted outdoors in May. This plan is only necessary when an early supply is required. For ordinary purposes sow outdoors in April, transplant the seedlings 6 inches apart in a nursery bed, and finally plant out in June. A third method is to sow in July, in the North, or August in the South; plant the seedlings 6 inches apart in a nursery bed, and plant out permanently the following May. Plant dwarf sorts 30 inches apart each way, and tall ones 30 inches apart in rows

3 feet asunder. The crop is ready to gather in November and onwards. Cut, not break off, the sprouts, and do not remove the heads until late in winter.

Savoy cabbage originally came from Savoy, and has been grown in Britain for three centuries. It requires the same soil and manures as advised for cabbage. Sow the seeds outdoors in April, and plant the dwarf sorts 1 foot apart in rows 2 feet asunder, in May or June. The crop is ready for use from October onwards.

Saladings.

Lettuce, radishes, celery, mustard and cress, endive, and cucumbers are the chief vegetables grown for salad purposes.

Lettuce was first cultivated in England in 1562, and long before then by the Romans and Greeks. The cos or tall, and the cabbage or dwarf, are the two types grown. To have a succession sow seeds outdoors in March, April, and May for summer use, and in August and September for winter use. The seeds can be sown broadcast or in shallow drills 1 foot apart. In either case thin out early to 8 inches apart, and replant the thinnings elsewhere. Lettuce may be grown in any spare plot where the soil is fairly rich. Give plenty of water in dry weather. The cos varieties should have a piece of bast tied round them about ten days before required for use in order to blanch them.

Radishes are natives of South Asia, and were a popular vegetable in the time of Pharaoh. The Greeks and the Romans, too, excelled in the culture of the radish. It was first introduced here in 1548. To grow good succulent roots quickly dig in plenty of rotten manure, and see that the soil is made fairly light. Make the first sowing in January on a south border, and further sowings at intervals of a fortnight or so throughout the season. The seeds are best sown broadcast, but may also be grown in shallow drills 6 inches to 8 inches apart. Thin out early to 2 inches to 3 inches apart, and give plenty of water in dry weather. Radishes may be grown between rows of peas or on asparagus beds; or, if early crops are desired, in frames on mild hotbeds. The crop is ready for use about six weeks after sowing. There are long, oval, and turnip-rooted kinds.

Celery is a native plant, and appears to have been grown more or less for the past two centuries. The seed should be sown in slight heat in March, the seedlings transplanted 2 inches apart in shallow boxes, kept in heat until the middle of April, then hardened off, and planted out on a warm border at the end of April. The bed should have 3 inches of rotten manure and 2 inches of light soil on top, and the seedlings planted 6 inches apart in this. Prepare trenches 1 foot wide and deep and 3 feet apart for single rows, or 18 inches wide, 1 foot deep, and 4 feet apart. Put 6 inches of rotten manure in the trench and 3 inches of soil on top. In June plant the seedlings 9 inches apart for a single row, or 9 inches apart in the row and 6 inches between the rows for a double row. Keep well watered. At intervals of ten days, until earthing up, give a gallon of the following solution to every yard of row:—1 oz. each of kainit, superphosphate, and sulphate of ammonia to a gallon of water. Keep all suckers removed. Commence earthing up in August, and repeat the operation gradually as the plants grow, finishing in September. Before earthing up draw the leaf stalks closely together, and secure them with bast. The crop will be ready for use six weeks after the final earthing up.

Mustard and cress may be easily reared in shallow boxes of ordinary

soil in a heated structure in early spring, or on a shady border outdoors from April onwards. Make the surface level, sow the seeds and press them into the soil with a piece of board. Give a good watering, and cover with mats until the seeds sprout, then expose the seedlings to the light. Make a sowing of cress once a week and of mustard every three days.

Endive was largely grown by the Romans and Greeks, and first introduced here in 1548. It is an autumn and winter vegetable. Seeds are usually sown outdoors in May, June, and July, to give successional supplies. Sow broadcast, or in drills 6 inches wide. When the seedlings have formed their third leaf, transplant them to a rich, sunny plot of ground, planting the moss-curled kinds a foot apart each way, and the Batavian sorts 1 foot apart in rows 18 inches asunder. Three months after planting draw the leaves together, and secure them with bast to blanch the hearts. Late crops should be lifted in October, planted in cold frames, and then be covered by a few inches of hay or dry leaves. It takes about a month to blanch the hearts.

Cucumbers were known to the ancient Israelites; the Emperor Tiberius is said to have had a daily supply throughout the year; and they were grown in England as far back as 1327. Those who have heated greenhouses may have a supply all the year round. For ordinary purposes, however, seeds may be sown in a temperature of 75 degrees in January, and the plants placed in a compost of two parts turfy loam and one part manure, on the staging. The plant should be allowed to grow with one stem till it reaches the roof, then have its point pinched off and three side shoots be permitted to form. When these get a foot or so long, their points should be removed also, a similar course being pursued with subsequent growths until fruit forms, when each shoot must have its point removed at the first leaf beyond the fruit. The plants have to be syringed morning and afternoon, the roots top-dressed with fresh compost directly they show through the surface, and also kept well watered and supplied occasionally with liquid manure. The temperature should be 60 degrees to 65 degrees by night, and 70 degrees to 75 degrees by day. In hot weather the roots must be shaded also. Cucumbers may also be grown in frames on hotbeds. A hotbed 4 feet to 5 feet deep, and a couple of feet wider than the frame, should be prepared in March in a sunny, sheltered spot. Place the frame on this and then put a good heap of compost under each sash. Sow seeds at the same time in a pot or box, and place it in the frame. When the seedlings have formed their first rough leaf, plant two on each heap. Shade from sun, syringe morning and afternoon, keep the soil moist and ventilate a little during the day. When the first shoot is a foot long, nip off its point and treat each subsequent growth similarly when a foot long. When fruit forms, remove the point of each shoot at the first leaf beyond the fruit. Liquid manure must be given occasionally when the plants are bearing freely. Ridge cucumbers, or gherkins, may be grown in a similar way from May onwards, or on a bed of manure and soil in a sunny spot in the open in June. They require to be trained as advised for those grown in frames.

Miscellaneous Crops.

Asparagus has been cultivated in Britain since the sixteenth century, and was also a favourite vegetable with the Romans. At one time a good deal of care, time, and expense was involved in the preparation of an asparagus bed, but modern practitioners have proved that this vegetable

may be grown with greater success in a more simple manner. For example, it is only necessary to trench the site of the bed 3 feet deep, and to add an abundance of good farmyard manure, leaf-mould, grit, and old mortar so as to render the soil rich and porous. Do this in autumn. Mark off the site into strips 3 feet wide, with paths or alleys 2 feet wide between. Dig out the alleys one spit deep, and place the soil on the beds, so as to raise them above the paths. Next mark off two lines on each bed, each being 9 inches from the edge. Along each line place sticks at 18 inches apart, these indicating the sites for the roots. Early in April procure three-year-old crowns and open a wide hole where each stick is placed, and let this be 6 inches deep. Scoop out the soil so that the centre of the hole has a cone-like point. Place the crown on this and spread out the roots downwards and cover with the soil. The buds of the crown should be 6 inches below the surface. In summer keep all weeds removed, and in autumn cut off the shoots. After this is done cover the bed with 2 inches of rotten manure. In April apply 1 lb. of salt per square yard, and lightly fork this in. Again, see that all weeds are removed, and in autumn cut off the foliage and top-dress as before. The third spring give another dressing of salt, and in May shoots may be cut for the first time. In July cease cutting. The following autumn treat the beds as before. In future years dressings of fish manure and seaweed may be applied in autumn, and Peruvian guano or nitrate of soda at the rate of an ounce per square yard in June. Soot is a good thing for asparagus beds, and may be used at the rate of 6 lb. per square yard, in April. Asparagus may be raised from seed sown in drills 1 inch deep and 1 foot apart, in April. When the seedlings are 6 inches high, thin them out to a foot apart, and lift and replant them permanently when they are three years old. Many practitioners make a point of selecting the "male" or non-seeding plants for beds, these yielding finer shoots than the "female" or seed-bearing ones.

Globe artichokes were introduced from South Europe into this country in 1546. They are not very extensively grown, because so few people really understand how to cook and eat them. They will only succeed on well-drained sandy soils. The soil must be deeply trenched and heavily manured and the suckers planted in groups of three, 3 feet apart in rows 4 feet asunder, early in April. Subsequent culture consists of removing the outer dead leaves in autumn, placing some litter round the base of the plants, giving a dressing of manure and digging this in spring. The flower heads are ready to gather in July. The plantation should be removed every four years.

Spinach has been grown in Britain for several centuries. There are two kinds, the summer and the winter. The former may be sown at intervals from March onwards in drills 1 inch deep and 1 foot apart between the rows of peas, or in any spare plot. The crop is ready for use about eight to ten weeks after sowing. Winter spinach should be sown in August in drills a foot apart. It does not do well in cold districts. Thin the seedlings out early to 4 inches apart. Spinach will thrive in any fairly good soil.

Rhubarb was, until a century ago, grown chiefly for its leaves, which were cooked and eaten like spinach. The kind grown in gardens is a hybrid between two Asiatic species *Rheum rhaponticum* and *undulatum*. It requires a deeply trenched and heavily manured soil. Good strong roots each furnished with a good bud should be planted 3 feet apart each way, and with the bud 2 inches below the surface, in February. Each autumn

the plantation should be heavily dressed with manure, and this dug in in spring. The bed should be renewed every five years. Rhubarb may be forced by covering the crowns in December with large pots or old casks, and these again with a mixture of fresh manure and tree leaves. Or two- or three-year-old roots may be lifted in winter, packed closely together with a little soil between in a warm dark cellar or outhouse, or in deep boxes in heated glasshouses. It is only necessary to exclude light and keep the roots moist. Outdoor roots should only be forced every alternate year. The best of the roots lifted for forcing may be replanted to force again in a few years' time.

Seakale is a comparatively modern vegetable. It grows wild on the seashores of the south coast of England, and very excellent shoots are obtained for cooking by those who live in the vicinity of the seaboard. It will grow in light or heavy soils which are well manured. The soil must, however, be deeply trenched. Seakale is increased by seeds and by root cuttings. In the former case draw drills 1 inch deep and 30 inches apart, and drop the seeds in groups of three and four at intervals of 2 feet. When the seedlings appear reduce their number to one in each group. The crop will be ready for the first gathering in March of the year following the sowing of the seed. Clear away the soil from the crowns and cut the latter off, otherwise the roots will produce flowering stems. The other plan is to select strong roots, about 4 inches in length, and cut off the top straight across, and then pare off the lower end slantwise. Open trenches 1 foot wide and 1 foot deep and 3 feet apart. In these plant the prepared roots, vertically, with their slant end downwards 2 feet apart, and with the upper end 2 inches below the surface. Cover with soil. When growth begins, rub off all shoots except one on each root. Any flower stems which may form later should also be removed. In autumn clear off decayed leaves, dress with manure and fork in. A plantation should be renewed every five years. Seaweed is an excellent manure for seakale. The plants may be forced in the open ground as advised for rhubarb, or the roots lifted as required, placed in boxes with soil between, kept moist and dark, and stood in a cellar or heated glasshouse.

Tomatoes originally came from South America, and although grown here in the seventeenth century, were really not appreciated until the last century. During the last thirty years they have become very popular, and are now grown in almost every greenhouse or garden. So far as greenhouse culture is concerned, the main factor to observe is not to grow the plants in too rich a soil. An over-rich soil promotes excessive leaf growth and a paucity of fruit. They may be grown in 10-inch pots, in boxes a foot or so square, or in beds of soil on the staging. The best soil consists of three parts loam and one part of decayed manure, with a 5-inch potful of bone-meal and similar quantities of kainit and wood ashes to every barrow-load of the former. This will produce a short-jointed, sturdy, and fruitful growth. Put 2 inches of drainage in the boxes and fill them to within 3 inches of their rims with the compost. For the staging, place a ridge of compost 2 feet wide and 1 foot high. Plant one seedling in each pot or box, and ram the soil down firmly. For stage culture plant a foot apart in a single row. The seeds should be sown in heat, in February or March, and the seedlings transferred to 3-inch pots and grown on until well rooted, before planting as above advised. Train the shoots up the roof, and allow only the main stem to grow, removing all side shoots. Let the main shoot grow until it reaches the top of the roof, then remove its point. As soon as two or three bunches of fruit have formed, top-dress the soil with

similar compost to that they are planted in, and then commence to feed. An excellent fertiliser consists of two parts nitrate of soda, one part dried blood, four parts of superphosphate and three parts of kainit. Use 1 oz. of this mixture to a gallon of water, and apply this quantity once a week to every six plants. Supply plenty of air when the sun shines, and daily at midday give each plant a gentle shake to distribute the pollen and ensure the flowers setting. A dry atmosphere is essential, but the soil must be kept moist. Tomatoes may be grown outdoors against sunny walls or fences, or in the open gardens. In the former case plant a foot apart, and in the latter case a similar distance in rows 4 feet apart. Grow the plants with one stem, and feed as advised for the indoor crop. When the plants are 3 feet high, nip off their points. Fork a little well-rotted manure into the soil before planting. Plant outdoors early in June. The temperature for indoor tomatoes should be 55 degrees to 60 degrees at night, and 65 degrees to 70 degrees by day.

Mushrooms, of course, grow naturally in our meads and uplands, consequently our forefathers made no attempt to cultivate them artificially in earlier times. During the last century, however, they were grown in special structures, and in later years still more extensively in the open air. In winter they may be grown in cellars or outhouses where there is an average temperature of 50 degrees to 55 degrees. They may also be grown all the year round in ridged-shaped beds outdoors. The main point in either case is the manure. Fresh horse manure with the long straw litter removed is the best material. Collect it daily and store in a heap in an open shed, turn the heap three times a week for about a fortnight, by which time it should be sweet and sufficiently hot. For an indoor bed shake out the manure well, and spread it to the required length and breadth of the proposed bed, and beat it down firmly. Proceed thus till the bed is a foot deep and quite firm. Insert a thermometer and examine this daily. At first the heat may rise to 90 or more degrees, but when it has declined to 75 degrees the time has arrived for inserting the spawn. Procure the best spawn available, and break each brick into eight parts, and insert one of these just beneath the surface of the manure at intervals of 9 inches. Press the manure firmly round the spawn. Next sift some loam through a ½-inch sieve and cover the bed an inch deep with this, and beat it down firmly. Watch the thermometer, and if the temperature falls below 70 degrees cover the bed with straw to keep in the warmth. No water will be needed unless the surface becomes very dry, and then only a slight sprinkle will be needed. Mushrooms should begin to appear in six weeks after spawning. Outdoor beds are best made in July or August. Prepare the manure as previously advised, mark off a bed 3 feet wide, and spread out the manure, and beat it down as already suggested. Gradually narrow the bed until it forms a ridge 3 feet high, 3 feet wide at the base, and 6 inches or so wide at the top. Spawn the sides as advised for the indoor bed, and cover it with an inch of loamy soil, and, in this case, at once with a foot or so of litter. Make the bed in a sheltered corner, and as long as convenient. Mushrooms will appear in six to eight weeks. The covering, of course, must be removed to gather the mushrooms, but replaced directly afterwards. The beds will continue bearing for two to three months according to the quality of the spawn used. When beds are not bearing freely sprinkle them with salt and water 2 oz. per gallon.

The vegetable marrow is a species of gourd, and originally came from Persia. It has probably not been grown in Britain longer than a century, is a delicious vegetable when cooked in a young state, and when ripe makes

a toothsome preserve. This vegetable may be grown on a heap of manure covered by a few inches of soil, or on the level ground. In the latter case, dig out holes a yard square and 2 feet deep, put in 18 inches of manure and 6 inches of soil on top. Sow seeds in heat in April, and plant out the seedlings late in May. Supply freely with water in dry weather, and when fruit forms give weak liquid manure occasionally. Pinch out the points of the strong shoots to encourage side growths to form, then the plants will bear freely. They require a sunny position to grow and bear well.

Herbs.

No garden is complete without a collection of herbs. Parsley should be sown thinly in drills a foot apart in April, the plants being thinned to 4 inches apart. Chives are useful for spring salads, and are easily grown by planting small tufts 6 inches apart in rows a foot asunder, in April. Fennel can be raised from seeds in March, or have its roots divided and replanted in spring. Sweet marjoram has to be raised annually from seeds sown out of doors in April, and pot marjoram is a perennial increased by the division of its roots in spring. Mint requires little culture. Plant the roots 2 inches deep, in rows a foot asunder in spring, and a bed will last for years. Tarragon may be grown in a similar way. Rosemary, hyssop, thyme, sage, and rue only need to be planted in spring to last for years.

Garget, Udder Clap, Downfall of the Udder, or Sore Udder (technically known as Mammitis, Mastitis, and Galactopheritis or Inflammation of the Udder) may be accompanied more or less by fever, is both acute and chronic, also simple or sporadic, complicated, infectious, and epizootic. The mammary gland or milk vessel in the domestic animals is mostly situated between the hind legs and along the under side of the belly, and is divided into sections or quarters, these being distinctly separated from each other, and containing milk cells, ducts, and sinuses or reservoirs, all being held together by connective tissue, and lined by a fine delicate mucous membrane. In the mare the gland or udder is divided into two, each half being provided with a conical-shaped teat having two openings at their free ends. The ewe and goat also have two halves, one on each side; these being furnished with a long teat with a single opening. The cow's udder is, however, divided into four quarters, two on each side front and back, and situated between the thighs, each quarter having a long teat with a single opening. Occasionally two supplementary blind teats are seen behind, but these are rarely provided with either glandular structure or milk ducts. In the sow the mammary gland runs along each side of the lower part of the belly extending from the hind limbs to the chest, and is separated into five or six sections each having a short broad teat with two or three openings. The bitch somewhat resembles the sow, having five or six teats on each side usually with five or six openings each.

The mare occasionally suffers from garget both before and after foaling, sometimes the trouble making itself manifest after some injury to the hind limbs or feet, the inflammation from which flies to the udder (metastasis); it also follows protracted cases of influenza, strangles, etc.; when there is much constitutional disturbance set up, it has to be combated with mild laxatives and fever medicines, and at the same time local treatment should be adopted, consisting of fomentations with warm water, followed by the

application of some soothing anodyne liniment twice a day; for this there is nothing better than 2 oz. of liquid extract of belladonna and 6 oz. of oil of camphor mixed; when abscesses form, which frequently happens, they have to be opened out; occasionally gangrene or mortification sets in, when one or both halves of the udder sloughs off, or the mare dies from blood poisoning (septic fever). The same thing may happen to both the sheep and goat. In the sow, garget arises chiefly from damage done by the sharp points of the young pigs' teeth, which lacerate the teats, inducing soreness and swelling, thus causing the mother to refuse the young to suckle, and eventually inflammation sets up. For treatment, foment the udder with warm water, and anoint the inflamed teats with a little vaseline, and at the same time level down the sharp points of the little pigs' four teeth (two corner and two tusks) with a fine file. The mammary gland of the bitch is more subject to morbid growths than that of any other animal, and these have to be removed by an operation.

The greatest sufferer, however, from garget is the cow, a predisposition to which may be said to be largely due to the abnormal development of the mammary gland, as a result of the continual drawing and milking to supply food, not only for her own offspring, but also for that of the human family. It is therefore of the greatest importance that every care should be used to keep this important organ in a healthy condition. The complaint is a very common one in the cow, and the causes are many, and one or more of the quarters may be affected; it has been frequently instanced that one great cause is that of overstocking after calving, but such has not, however, been the experience of the writer, cases from this source being very limited. Garget may arise from any one of the following causes, namely, derangement of the digestive organs, the liver in particular; sore, warty, or cracked teats; vesicular eruptions, as from foot-and-mouth disease; from kicks, or wounds caused by barbed wire, stakes, thorns, etc.; treads on the teats by the feet of other cows while the beast is lying down—a frequent occurrence; irregular milking; sudden chills; stricture; obstruction of the passage of the teats from small growths; and the too frequent injudicious introduction of the teat syphon. It is, however, most prevalent in hot, dry summer weather, when it may occur and rage like an epidemic, particularly if the dry weather has been followed by a sudden and heavy fall of rain, this occasionally producing as many as fifteen to twenty cases in as many hours, having all the appearances of being contagious; and no doubt these cases are due to disease-producing germs finding their way into the milk sinuses and ducts through the opening into the teats. Another frequent cause during the hot weather is when the cows are annoyed by the presence of the warble fly wanting to deposit its eggs for their winter shelter on the animals' backs, which causes them to gallop at break-neck pace over hedges and ditches, and finally rush into a pond or river and there stand for hours up to the belly in cold water, where the warble fly will not follow; or, again, the cows may stand in the shade under the branches of trees, and thus contract a chill, with the result that after the udder and teats, which are bruised by the furious gallop, become relaxed, and the pathogenic germs gain access to the internal parts, and eventually set up inflammation. Nearly all classes of cattle are liable to suffer from these two latter causes, such as young heifers, strippers, stock animals, in-calf cows, as well as milch cows.

Garget varies greatly in character according to the severity of the attack; in the simple or catarrhal form the teats are noticed to be pointed and the quarters distended, when a straw-coloured fluid intermixed with shreds of

clotted milk is drawn from the teats; this occurs when the lining of the milk ducts only is affected; but, as the complaint progresses, the formation of muco-purulent matter or pus follows, and finally the inflammation extends to the walls of the quarter, and the connective tissues become involved, resulting in what is known as *parenchymatous mastitis*, with the formation of troublesome abscesses, or the walls of the gland may become hard (indurated). In some cases, particularly those following milk fever, where the udder has been injected with medical agents now used for that complaint, gangrene or mortification sets in, and the quarter or quarters slough off, or the animal dies from septicæmia (blood poison).

Symptoms.—These, like the complaint itself, vary according to the nature of the attack; when the attack is slight, little or no inconvenience is observed, only the animal walks rather stiffly and the teats are noticed to be pointing, with a hardening of the quarter affected. In the more aggravated form the animal is off its food, stops cudding, breathes quickly, with a temperature up from 104° to 106° Fahr., the udder becomes hard and painful and the bowels constipated, the beast walks stiffly or decidedly lame with the hind limbs, at times accompanied by swelling of the legs and great constitutional disturbance; the complaint is also much intensified by the inflamed udder being allowed to hang pendulous from the body without any support.

Treatment is not at all times satisfactory, and much injury is done to the tender sensitive structures by the application of strong irritating liniments, which is too frequently done. When an attack in the catarrhal form is first observed, the animal should be put into a well-ventilated loose box by itself, and the udder fomented for forty to sixty minutes with warm water, and immediately after the parts washed with cold water for four or five minutes and then rubbed perfectly dry with a soft cloth; this should be done night and morning, and at the same time the teats drawn and a liniment applied, made from the following ingredients, well mixed together, namely, carbolised oil 6 oz., liquid extract of belladonna 2 oz. Too frequent pulling of the teats to strip out the morbid matter causes great irritation. When an animal is first noticed to be ailing, a dose of laxative medicine varying from 12 to 16 oz. of Epsom salts and 1 oz. each of ground ginger and saltpetre should be mixed and given as a drench in 1 quart of thin gruel; and, if necessary, half of the above medicines may be administered each end of the day for three or four days, or until the bowels respond freely; but in all cases of garget the greatest success in its treatment is obtained, if the owners will only take the trouble, by covering up the affected parts after the fomentations and application of the liniment with cotton wool, and support with a bandage round the loins and over the quarters. When a case assumes a chronic form, inject into the affected gland, 10 grains of chinosol dissolved in 3 gills of water which has been previously boiled and allowed to cool, and repeat if necessary. Should the organ become indurated (hard), the application of a 15 per cent. oleate of mercury ointment has a good effect. In many cases where the udder becomes distended with pus, great relief is obtained by splitting open the teat or cutting it off half-way up to give exit to the matter. There are other diseases affecting the udder of the cow in addition to garget, such as calculi (stones), actinomycosis, tubercular deposits, and growths or tumours of various natures, all of which have their special symptoms.

Prevention.—In hot summer weather, when practicable bring the cattle indoors during the extreme heat of the day, and thus prevent them galloping to avoid the attention of the warble fly; or smear the backs of the cows once a fortnight during the summer months, from the top of the shoulders

to the tail-head, with a mixture made from 1 lb. of flowers of sulphur, 1 quart of spirits of tar, and 1 gallon of train (whale) oil, all mixed well together. This preparation answers splendidly in warding off the attacks of the warble fly, and is known as Thompson's mixture, and was greatly recommended by the late Miss E. A. Ormerod, LL.D. At the same time attend to the proper and regular milking of the cows, as well as to their systematic and judicious feeding and general comfort.

Authorities.—Dollars' *Diseases of Cattle and Sheep*; Leblanc's *Diseases of the Mammary Gland*, translated by Colonel Nunn; *Steel on the Ox*; and Thompson's *Elementary Veterinary Lectures.*

Garron.—*See* Highland and other Ponies.

Gas-lime is one of the waste products of gas-making. It has obtained a certain degree of popularity among farmers on account of its strong odour, and its well-known effect in stopping the ravages of slugs and insects. Its manurial value is best arrived at by considering its origin, preparation, and composition; and it will be seen that it cannot be high, while its nature evidently renders the material noxious and even destructive to animal plants. These properties indicate that it should be used with caution, and after long exposure to the air, unless it is intended to act injuriously on certain forms of life. It is, originally, quick-lime, over which coal gas is passed after it has been deprived of its ammonia (gas liquor) and tar, and the final contact with lime is necessary to remove sulphuretted hydrogen which would render the gas offensive. This acid gas forms a sulphide with the quick-lime, and confers a rank and disagreeable odour upon the resulting gas-lime. It is not regarded as of any special value by agricultural chemists, although it certainly does contain lime and sulphur. It is probably of no more value than lime. By exposure to the air the sulphide is gradually converted into sulphate of lime (gypsum). It is recommended for application in the fresh state as a lining close to hedge-rows to check the incursions of slugs. It has also been employed in combination with quick-lime, sulphur, soot, and powdered road scrapings, for dosing turnip fly; but this latter use is now superseded by better compositions suitable for wet or dry spraying. It has been applied as a top-dressing to mossy grass land, but when so used reliance is placed on the fact that it is freely exposed to the air, and until its offensive properties are destroyed its action must be injurious.

Gastritis.—The term gastritis is used to denote inflammation of the stomach, or, as sometimes more narrowly defined, inflammation of the true digestive stomach. In considering gastritis as affecting the domesticated animals, we must bear in mind that the first three compartments, the rumen or "paunch," the reticulum or "honeycomb," and the omasum, "manyplies" or "maw," through which food first passes after being swallowed by the ruminant (ox and sheep), are not regarded as true digestive stomachs, but merely as food receptacles. In the horse and pig the food, like that of man, passes directly from the œsophagus into the true digestive stomach.

Gastritis may be acute or chronic. When the inflammation is limited to the mucous membrane lining the internal surface of the stomach, and the products are thrown off as cells and liquid, the condition is termed

muco or *catarrhal gastritis* or *gastric catarrh*. Affecting deeper parts, gastritis is sometimes termed *phlegmonous* or deep-seated.

Inflammation of the stomach is most frequently caused by something which irritates its inner lining membrane, and such irritants are often taken by the mouth. The micro-organisms of some specific contagious diseases induce inflammation of the stomach; we may instance those of swine fever, cattle plague, Cape horse sickness, distemper of dogs, and white scour of calves, while some inherent weakness may occasionally predispose. Improper food and manner of feeding, and imperfect mastication, are enumerated among the causes, and there is less room for doubting that irritant and corrosive poisons are properly within the category. The more commonly recognised causes of gastritis in animals of the farm are parasitic worms, and the so-called *parasitic gastritis* is responsible for serious loss, particularly of cattle and sheep.

The symptoms of gastritis are most varied in character. By some gastritis is taken as synonymous with "indigestion," and there can be no doubt that some cases of indigestion are due to inflammation of the stomach, while it is certain that indigestion may occur independent of gastritis. The symptoms will, however, largely depend on the fact that when the stomach is inflamed the secretion of gastric juice is interfered with and food is imperfectly digested. Continued inflammation is liable to permanently damage the mucous membranes, and set up a state of chronic indigestion. Undigested food passing from the stomach to the intestine may become a cause of intestinal colic or diarrhœa. The food not being digested is not applied to the sustenance of the animal, so that flesh is lost and anæmia induced. The marked differences in manifestation in animals of various species will necessitate a few special remarks referable to each.

Acute deep-seated gastritis of the horse, resulting from swallowing some strong irritant, as *arsenic,* corrosive sublimate, vitriol, etc., is manifested by the evidence of great abdominal pain, kicking at the abdomen, crouching, lying down, rolling, etc., sometimes gulping as though attempting to vomit. The appetite is usually in abeyance. The animal is much depressed. Similar symptoms are noticed in *cattle, sheep,* and *pigs,* while vomition is frequent in the last named, whose acute gastritis is more commonly due to salt poisoning through drinking brine. The termination is usually fatal in course of a few hours or days.

Acute catarrhal or superficial gastritis affecting the horse and pig may depend on the same agencies, occasionally on worms or bacteria, when the symptoms may be of the same type, but less acute. *Cattle* and *sheep* may suffer in this way from similar causes, but these animals owe their acute catarrhal gastritis most commonly to worms, and the principal symptoms are wasting, anæmia, and diarrhœa. Some of these cases terminate rapidly in death; especially is this so with sheep. With *cattle* there is a greater tendency for the affection to assume the sub-acute or chronic type. In the more acute cases the appetite may be absent from the first, but in the less acute it may remain till near the end. But there is nearly always a disposition to eat gritty matters, which are usually found in the stomach after death. In the most chronic form the affected animal is usually known as a "waster," "scanter," etc., the loss of flesh, anæmia, and diarrhœa continue, and the appetite is maintained till the animal is practically a "bag of bones." When gastritis is painful, the symptoms of abdominal uneasiness are more marked after eating. The above cannot be regarded as a complete description of the symptoms which may be associated with gastritis, which interferes with the nutrition of almost

every part of the body, and so gives rise to a great variety of disturbances. Reference will be made to the subject under other headings dealing with matters which include it.

The treatment of gastritis will depend principally on the cause. In case of irritant poisoning the proper antidote must be exhibited and other suitable measures adopted. As one manifestation of a specific disease, its cure will be embraced in the treatment indicated for such disease. Under Parasitic Gastritis the means of prevention and cure will be considered. Under all circumstances the most easily digested food should be offered.

Gean, The.—*See* Cherry.

Geese.—*See* Poultry.

Gelding.—*See* Castration.

Geology (Agricultural).—The application of the study of geological science to agriculture is not of recent date, but it became somewhat obscured during the last generation or so, and it is only now in our time that it has become revived. In the *Journal* of the Royal Agricultural Society of England, from the first number onwards, there have been countless articles on the subject devoted to every phase of it. It was indeed an article in one of these bygone volumes on the Agricultural Geology of Devon and Cornwall by De la Beche which led to the foundation of the Geological Survey of this country, and an instruction to the officers of the same was to make their survey for agricultural as well as for mining and quarrying purposes—an order carefully disobeyed from that day till the present time.

The British Islands in their geological structure are an epitome of the world, and as the rock formations and the soils on the top of them are the basis of the farming in all countries, it follows that the varieties of farming are almost as numerous as those formations, even within our narrow limits.

The soil itself is a geological formation, the very latest one, and one still in the course of making. It consists simply of the weathered or "decomposition products" of the rocks forming the "solid" geology below, or of the "drift" material which has been deposited in bygone æons by geological agencies—ice, water, volcanic disturbance, etc.—together with a certain proportion of humus or organic matter which has become mixed with it in the course of time from the decay of plants and animals. In some few cases—as with alluvial soils—it has been transported from another district and deposited where we now find it, but in the great majority of cases it has been made out of the material—either solid or drift—already on the spot, by the ordinary disintegrating agencies—frost, rain, atmospheric oxygen, etc. etc.

When rock material is exposed to the action of water, frost, the oxygen in the atmosphere, and all the other weathering agencies, it begins to get disintegrated, and a lot of débris or broken up and altered rock material will accumulate somewhere: this débris forms the mineral part of the future soil and subsoil—generally the greater part of the bulk or weight, which, after complete weathering and mixing up, accumulates a certain

amount of organic matter in the same from the growth and decay of plants and animals—as already said—and becomes a true soil in contradistinction to the "subsoil."

It is pretty evident from the above that, as the bulk of any given soil is formed from wasted rock material, the resultant soil must take its character from the nature of the original rock. Thus a sandstone formation will give rise to a sandy soil, a claystone deposit yield a clayey soil, a marlstone deposit a marly soil, and so on with a host of other varieties. It will therefore be found in actual practice that the rocks are the key to the nature of the soils of any district, while *per contra* professional geological surveyors often infer the nature of the underlying rocks from the soil on the top.

Every farmer who has the most elementary knowledge of the soil is aware of the vast differences there are between the varieties of it, not only as regards places far apart, but even within the boundaries of the same farm or field. We find, for instance, a stiff clay soil in one part, a light sandy variety in another; a rugged rocky district in one place, and a fertile marl somewhere else. These differences must puzzle farmers who have ever thought of the matter, and with certain thinkers of a bygone generation the thinking ended in the evolution of the science of Geology. William Smith, "the Father of English Geology," was a farmer and land valuer, and in his journeys up and down the country noted the superposition, sequence, and nature of the rocks and soils with a view of gaining information to help him in his business, and the schemes he evolved and maps he produced were the foundations on which all the geologists of a later date built upon.

It must be explained that there are two kinds of geology, the "solid" and the "drift," and a complete study of the geological structure of any district involves two sets of maps. The solid geology is the structure of the original formations of deep-seated rocks—the ribs and the backbone of the country as it were—which determine all the scenic characteristics of a region as to mountain, river, valley, plain, etc.; while the "drift" refers to certain surface accumulations of more recent date which have been laid down on the top of the others, principally by the action of ice and water, and before the advent of man, and on the surface part of which the true soil has since been formed.

This "drift" material is mostly classed geologically either as Boulder Clay or Glacial Drift. This wreckage was left as the result of the Great Ice Age, and it buries the "solid" formations in some places, and indeed constitutes the formations of certain districts, and requires to be studied as such, and therefore it is necessary to study these "drift" formations *per se*, and allow for their influence on the surface conditions—as these only concern a farmer.

In the case of some few of the mining districts the "six-inch" geological maps are issued, but, as a rule, the ordinary "one-inch" maps of the Geological Survey are the most useful. Both "drift" and "solid" maps are necessary for a complete knowledge of the subject, but of course the drift series is the most useful to a farmer. Unfortunately, the authorities have only in recent times awakened to the necessities of the case and begun to issue the latter, and so these are only as yet available for the most part for the east and south of England. Any farmer who wants to understand thoroughly the distribution of soils and their varied nature will do well to invest in the sheets of his neighbourhood, while in the case of a prospective farmer looking for a farm, these maps would give him important information in advance that would be worth much to him.

It is not merely, however, as a key to the origin, nature, and distribution of soils that geology is valuable, but it is also a key to the nature of a whole country-side. The colours on the maps, which are used to indicate the kind and extent of the different rocks, also indicate to one who can read them the nature of the scenery: a rugged granite hill in one place, a level alluvial plain in another; here a stretch of barren sandy heath worth nothing, and there a district of rich marly soil, undulating in contour, and worth a big rent per acre.

In an article of this kind it is impossible to give more than a bare sketch or outline of the application of geological facts to agricultural conditions, but an attempt will be made to do the thing as clearly and briefly as possible.

Extended and long-continued study and examination of the crust of the earth has shown that while there are in round figures from 200 to 300 different kinds of rocks composing the geological strata, these strata are always found in a certain order of superposition. One kind only may be found in a given district, and in a whole country like say Scotland many rock formations may be awanting, but the *order* of these is always the same: we always find, for instance—to take well-known names—that the Old Red Sandstone is below the Coal Measures, and the Chalk below the London Clay; never the other way about.

Again, the same kind of rock is always of the same nature no matter from what part of the world it has been obtained: the minerals it is composed of, or the chemical bodies in it, are alike. Thus a sandstone is always composed more or less of consolidated sand; a claystone of consolidated clay; a limestone or chalk of carbonate of calcium, and so on all the world over.

It is impossible to go very much into detail in a short article, and therefore only a few notes on the agricultural characteristics of the principal rock formations of this country are here given.

Beginning at the bottom of the series with the igneous rocks we may take *Granite* first, though this is not really the oldest of our rocks. A granite country is one of the most rugged and sterile nature, bare rocky hills with few trees and thin soil, and only suited to sheep and cattle walks wherever met with in the British Islands. Many of our "moors" are on granite hills or bosses, and arable farming is impossible.

Trap rock is a general name given to various kinds of igneous rocks found in various places. They weather down into fertile loams more or less brown in colour from the presence of iron oxides, and Johnstone has pointed out that much of the fertility of the soil of the Lowlands of Scotland is due to an admixture of fragments of these. These Lowlands are largely covered with boulder clay and drift, but their natural inferiority has been naturally improved in this way, plus good farming.

The *Fundamental Gneiss* of the north-west of Scotland and the Hebrides is the lowest and oldest and most rugged of all the sedimentary rocks—a series of districts only fit to grow sheep and cattle and men, but with little possibility in the way of cropping.

In Wales, through the greater part of the Highlands and elsewhere, there are a series of beds which form rugged mountainous hilly counties only one degree more adapted for farming than the last, and to which the name *Cambrian* is given, from the ancient name of Wales. These are largely composed of shaly and slaty rock, and support sheep and cattle of the hill breeds only, excepting in the lower reaches in the river valleys.

The "southern Highlands" of Scotland, the southern part of Wales, and various other parts are formed of slaty and fissile rocks classed as *Silurian.* The country underlaid by such is not so rugged and broken up as that on the previously mentioned groups, but is still very rocky and with much waste land. The lower parts of these districts have generally a soil of the nature of a free working loam, but very full of stones and rock fragments, and very deficient in lime. It is the basis of some good arable farming.

Some of the beds of the *Old Red Sandstone* group—especially the *Old Red Marl*—yield the finest soils in Great Britain. The famous "red soil" of Dunbar, the apple orchards of Hereford, the "Golden Vale" of Tipperary, and many other exceptionally fine districts, are on this formation, as are some other of the favoured spots of these Islands, while the same rule applies to many Old Red Sandstone districts abroad. It is indeed almost an axiom that the finest soils all over the world are on the Old Red Sandstone group.

A very large part of the rugged and hilly country which runs from the Borders to Derbyshire is composed of *Mountain Limestone*—the "Backbone of England"—a celebrated sheep district, where many breeds of the Black-faced type have originated; much broken up by exposed rock, but covered by short sweet pasturage.

Some of the beds of the *New Red Sandstone* are as fertile as those of the Old Red, but, on the other hand, some of the purely sandstone beds give rise to barren sandy heaths. The New Red Marl (Keuper) is the basis of the fertile red marly soil of the English Midlands, and the most noted districts for several of the principal kinds of cheese—Cheddar, Cheshire, etc.

There are great stretches of clay soil in the midland and southern half of England which are situated on one or other of the clay formations: *Lias Clay, Oxford Clay, Kimmeridge Clay, Weald Clay,* and *Gault Clay.* The land is more or less level or undulating on these, and mostly in pasture. In some places it has been under cultivation in the olden time, and been since laid away in grass. There are immense ridges and furrows (generally crooked) left across the fields as a relic of the ancient agriculture.

The *Great Oolite* yields a free working soil, full of fragments of the original limestone rock ("brash"). The arable land is exceedingly suitable for sheep folding, while the Cotswolds, Cleveland in Yorkshire, and a large part of the Midlands overlie this group.

The *Upper* and the *Lower Greensand* form two groups very different from one another in their agricultural and general characteristics. The Upper is the basis of some of the finest of the lighter soils in England, while the Lower is just the reverse—yielding barren heaths and sands.

The *Upper* and the *Lower Chalk* have a difference very similar to that of the Greensand. The Lower yields a thin light soil very suitable for roots and sheep-folding, while the Upper is the basis of many of the "Wolds" and "Downs" and other chalk hills, the habitat of the South Down sheep and some other breeds.

Of the Tertiary deposits the most important is the *London Clay,* which underlies the London and Hampshire "basins." It is a dense brown clay in the upper layers, mostly in grass, but good for beans, wheat, and clover where it is more workable. The practice of bare-fallowing is much carried out on this soil, as it is found mostly in the driest part of England.

Of the newer formations the *Boulder Clay* is the most important. This is mostly a dense clay full of blocks, or stones broken off from rock deposits by the ice in the Great Ice Age. It covers a large part of Scotland and the north of England, and is indeed the surface formation which is the basis of many of the soils there. It is mostly of a stiffish clay nature, but often

grades off into the newer beds classed under the head of the *Glacial Drift*, which latter yields gravelly and sandy soils. In the south of England the former is represented by the "chalky boulder clay"—really a marl—yielding one of the best examples of a medium soil, good for wheat-growing.

The latest formations of all—*Peat* and *Alluvium*—cover many square miles alongside the course of rivers, and form great stretches of level land. Peat, however, will form in any hollow where water stagnates, especially in northern districts, as well as alongside or part of river alluvium. The soil of a deposit from a river is generally the richest in that neighbourhood as it is more or less composed of silt washed from all the deposits further up the stream, and thus has a share of everything. It is often low-lying and swampy, however, subject to floods and requires elaborate draining to fit it for agriculture.

Agricultural geology, however, does not stop at a study of the origin, nature, and distribution of the soils of our country, and of the crops grown on them, but has a great deal to say regarding the many breeds of live stock we meet with in these Islands. Our country has samples of nearly all the geological formations in the world, and it is a very striking fact that we have such a tremendous number of distinct breeds of live stock as well —probably as many as there are in the whole of the rest of the world. Darwin, the great naturalist, showed that in olden times every district, hill, forest, or other distinct region had its own peculiar varieties of live stock. The greater number of these have disappeared in recent generations, but the names of many of them are to be found in the books written by authors on live stock of long ago, or linger in the memories of the old inhabitants. In round figures there were probably twice as many varieties of live stock in the British Islands a hundred years ago as there are to-day, each of which was as distinct from the others as the present-day breeds are, that are looked after by societies, and have their pedigrees registered in stud, herd, or flock books. These old breeds have disappeared under the stress of artificial selection and modern competition. The most prominent or best varieties were selected by farmers for improvement—like the Shorthorn among cattle, and the Leicester among sheep—and were thus brought to the front as it were, while the less important local varieties were allowed to die out. The dying-out process, however, has ceased in our days; and now there is a tendency to resuscitate some of the old breeds that still linger in corners of the country, and almost every year now sees the formation of a register and a society devoted to the development of some old breed of live stock hitherto unknown to farmers generally.

From a geological point of view, however, the great fact appears that it is our immense variation of geological formations that has brought about the differentiation of our breeds, for there is nothing else to account for the same.

In the case of horses we start in the early centuries with the Keltic ponies, the Norman horse, the great horse of the Fens, and later with the Arab, and in our days we find them divided into at least a dozen different breeds, with perhaps another dozen kinds mentioned in history, but now extinct.

With cattle we begin with two breeds only, the Keltic ox and the Germanic *Urus*, at the end of the Roman occupation, and in the fifteen centuries since we have seen them split up into at least fifty breeds, twenty of which are recognised at the present day. So of sheep and pigs: two or three kinds known at the beginning of written history have differentiated through the centuries into an endless number of breeds.

If the immense variety of our rock formations has produced a corresponding variety in the breeds of live stock, it may very naturally be inferred that the reverse state of matters—a wide country of one or few kinds of formations—will be accompanied by a sameness (or want of distinct breeds) among the live stock. That this is so, one or two examples will suffice to show. The whole of Central and Southern Russia—stretching from the Carpathians to the Urals—is underlain by only one or two formations, and the "black earth" of the great plains is really the sediment deposited by the waters of a great inland lake. The province of Perm, which gives its name to the Permian group of formations, is as big as France, and only one rock is found throughout it. The result of all this is that over a stretch of country 1500 miles across there is only one breed of cattle, the white longhorns of the Steppes—the "Sarmatian ox" known to the ancients.

Another analogous case is the bison of the American prairies — now extinct. Over a region twenty times larger than the British Islands there was only one kind, because the nature of the country and the pasturage is of one sameness; but whenever we go off the treeless plains into the hills and forests—*i.e.* on to other formations—we meet with an entirely different breed of bison—a variety still plentifully in existence.

But another converse of this, again, ought to be true. If a varied assortment of rocks produced various breeds, then the removal of those breeds to a region where there are no geological variations will tend to obliterate the distinctions of "breed." That this is what happens one has only to read Colonial and American farm papers to get proof of. An individual animal cannot change its own characteristics when exported—excepting that it may become "feral" if turned out loose—but the introduction of sires from Britain will not permanently alter the natural character of the varieties already there, and if whole herds or flocks of British breeds were turned out and allowed to range and breed at will, they would in a few generations evolve a new variety to suit the locality, but very different from, and probably inferior to, the original breeds. This tendency of our highly differentiated breeds to change and deteriorate when moved into a different kind of country is very marked, and is often commented on by Colonial and American writers. It is this fact that is indeed at the bottom of the export trade of pedigreed animals: it is constantly necessary to "renew the blood" so as to keep the native "scrubs" up to the mark.

Gestation.—Gestation, utero-gestation, or development of the fœtus of the viviparous animal, is analogous to incubation as applied to the oviparous. Gestation really follows conception, which entails fertility of the ovum of the female and the seed of the fecundating male. Conditions which prevent conception will be dealt with under the head of Sterility. During the first and second week the impregnated ovum is believed to remain free in the womb, after this it becomes enclosed in membranes or *fœtal envelopes*, through which nutritive matter passes from the blood vessels of the womb for the support of the fœtus. Fluid accumulating in the membranes affords protection during uterine life, and assists in parturition. The membranes ultimately become expelled as the "after-birth." The part of the membrane in closest connection with the walls of the womb and through which the nutritive material passes is termed the *placenta*. This is largely composed of minute blood vessels which, as it were, dovetail into those in the

wall of the womb. The arrangement of these vessels varies very markedly in animals of different species. Thus in the placenta of the mare and sow they are evenly diffused over the whole of the membrane, which, on expulsion, appears uniformly red. In the cow and sheep the vessels are arranged in patches, which are sometimes called "cotyledons." In the bitch and in woman they are in form of a circle. The blood vessels which carry blood from the mother form part of the umbilical or navel cord, which is severed at birth.

The period of gestation, usually reckoned from the date of service of the male to that of birth of the young animal, varies in the different species. In a general way it is taken that the larger the animal the longer the term of gestation, thus in the elephant it is 20 to 21 months, while in the mouse it is only 3 weeks. Its duration is not absolutely fixed for each species, though the record of many experiences allow of fixing an average time and a fairly definite range. That of the mare and she ass is usually set down at 11 months, the average is 345 days or 49 weeks 2 days, and the range 330 to 365 days, though it has been known to extend to 380 days. That of the cow taken roughly as 40 weeks or between 280 and 285 days, and the range from 230 to 300 days and even more. The ewe usually goes from 21 weeks 3 days to 22 weeks or 150 to 154 days, with a range of 20 weeks 6 days to 23 weeks or 146 days to 161 days. The period of gestation in the sow is commonly spoken of as being 3 months 3 weeks and 3 days. It really has a range of from 109 to 123 days, *i.e.* 15 weeks 4 days to 17 weeks 4 days. Male animals are usually carried a little longer in the womb than females.

The table on the facing page readily shows the approximate date of foaling or calving after service on any day in the year. The date of service is set at the head of each column, and underneath against "mare" or "cow" will be found the day of the month on or about which parturition may be expected. The name of the month placed on the left applies to figures on the same lines up to the number of days in that calendar month. The name of month on the right applies to days in the line after those, that is, in the following month.

In the early stages of gestation the growth of the fœtus is slow, but development advances in regular order and at a fairly definite pace. The various structures and organs are appreciable at definite dates, and the size is approximately the same at stated periods. The duration of pregnancy can be pretty well gauged by examination of the fœtus. The table on page 260 shows the average length of the fœtus in the different species at several periods.

Gestation to full period depends on sustained vitality of the fœtus, and this on its inherent powers and suitability of its surroundings. Development may be interfered with, and partially or totally arrested by a variety of means. Mechanical injuries, nervous impressions, as through fright, ingested poisons, disease germs or their products affecting the general system of the dam, as in influenza, pleuro-pneumonia, cattle plague, etc., and others affecting especially the womb and so rendering it unsuitable. By far the more frequent cause of arrest of development is the germ of contagious abortion so rife amongst cows and ewes, and to a lesser degree affecting mares.

When the period of gestation is completed, and the fœtus becomes independent of nutrition through the vessels of the womb, it ceases, as it were, to be part of the mother, and is expelled. Occasionally gestation may be totally arrested and the dead fœtus remain in the womb, without

	January	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	January	
Mare	December	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	December	*Mare*
Cow	October	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	November	*Cow*
	February	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	...	...	...	February	
Mare	January	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	...	...	...	January	*Mare*
Cow	November	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	...	...	...	November	*Cow*
	March	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	March	
Mare	January	29	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	February	*Mare*
Cow	November	30	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	December	*Cow*
	April	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	...	April	
Mare	March	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	...	March	*Mare*
Cow	December	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	...	January	*Cow*
	May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	May	
Mare	March	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	April	*Mare*
Cow	January	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	1	Feb. & Mar.	*Cow*
	June	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	...	June	
Mare	May	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	...	May	*Mare*
Cow	March	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	...	March	*Cow*
	July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	July	
Mare	May	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	June	*Mare*
Cow	April	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	May	*Cow*
	August	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	August	
Mare	July	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	July	*Mare*
Cow	May	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	June	*Cow*
	September	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	...	September	
Mare	July	30	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	...	August	*Mare*
Cow	June	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	...	July	*Cow*
	October	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	October	
Mare	August	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	September	*Mare*
Cow	July	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	August	*Cow*
	November	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	...	November	
Mare	October	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	...	October	*Mare*
Cow	August	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	...	August	*Cow*
	December	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	December	
Mare	October	31	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	November	*Mare*
Cow	September	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	October	*Cow*

giving rise to appreciable systemic disturbance in the dam. At other times its existence is manifested by a chronic fœtid discharge from the womb through the vagina. It, however, more commonly happens that soon after its death the fœtus is discharged as an abortion. Circumstances connected with abortion usually endanger future gestations, and it often happens that a female which has aborted once does not carry to full term again for a considerable time.

Horse.	Ox.	Sheep.	Pig.
28th day, $\frac{1}{2}$ inch	28th day, $\frac{2}{5}$ inch	18th day, $\frac{1}{3}$ inch	21st day, $\frac{1}{3}$ inch
		25th day, $\frac{2}{5}$ inch	24th day, $\frac{1}{2}$ to $\frac{3}{5}$ inch
6th week, $1\frac{3}{5}$ inch	6th week, $\frac{4}{5}$ inch	5th week, 1 inch	28th day, 1 inch
7th week, 2 inches	7th week, $1\frac{1}{5}$ inch		37th day, $2\frac{1}{5}$ inches
8th week, $2\frac{3}{5}$ inches	8th week, 2 to $3\frac{3}{5}$ inches		
9th week, $3\frac{1}{5}$ inches	9th week, $3\frac{1}{5}$ inches	8th week, 2 inches	8th week, $3\frac{3}{5}$ inches
10th week, $3\frac{4}{5}$ inches	10th week, $3\frac{3}{5}$ inches	9th week, $3\frac{3}{5}$ inches	
11th week, $4\frac{1}{5}$ inches	11th week, $4\frac{2}{5}$ inches		
12th week, $4\frac{3}{5}$ inches	12th week, $5\frac{3}{5}$ inches		
13th week, $5\frac{3}{5}$ inches			
14th week, 6 inches	13th week, 6 inches	13th week, $6\frac{2}{5}$ inches	10th week, $5\frac{1}{5}$ inches
22nd week, $14\frac{3}{5}$ inches	20th week, $12\frac{2}{5}$ inches		
34th week, about 27 inches	32nd week, about 25 inches	18th week, 10 to 13 inches	15th week, about 7 inches
48th week, 36 inches	40th week, 32 inches	21st or 22nd week, about 18 inches	16th or 17th week, 10 inches

There appears to be no definite limit of age as to when farm animals of any species may be capable of gestation. It may be taken that when conception is possible, age has little influence on gestation. The conditions in the very young and very old are usually regarded as less favourable both to parent and progeny. Opinion varies considerably as to the most fitting time to commence breeding from farm animals of the different species. This is a point which cannot be fixed at any particular period of

life, though theory and practice appear to indicate that more vigorous and valuable stock is bred from females after their own development is advanced towards maturity.

Pregnancy, that is the state of the female during gestation, is usually manifested by absence of œstrum, though this is not invariably the case, by closure of the mouth of the womb, a quieter and more contented disposition, swelling of the abdomen, which tends to become pendulous, decrease of milk supply (in cows) as the period advances, and in the later stages by movements of the fœtus in the womb, which are usually more marked after draughts of cold water, and rather sudden pressure on the right flank. Examination *per rectum*, though to be undertaken only by the expert with great care, will yield definite indications when pregnancy is advanced and the fœtus alive. It is possible in the human female to detect the beats of the fœtal heart by using the stethoscope, but this is a refinement which cannot be relied on, at any rate by the stockowner.

The pregnant animal requires little special care beyond that of a regular life. Over-feeding and under-feeding are alike undesirable, and either may prove detrimental to gestation. It is important that feeding should be regular, and large meals, specially of frozen food, must be avoided. It may, however, be taken that though the pregnant female should not be subjected to violent movements or great exertion, observation of the laws of health usually applicable to the species is all that is really necessary.

Gid or Cœnurosis.—This, like some other diseases which have been long and frequently recognised in many different localities, has acquired a variety of names, the more common of which are "Gid," "Giddy," "Dunt," "Sturdy," "Turnsick," "Goggles," and "Vertigo," each being expressive of some more prominent symptoms. The technical name "Cœnurosis" indicates the cause on which the symptoms depend, the *Cœnurus cerebralis*, the hydatid or intermediate form of a tape-worm, the *Tœnia cœnurus*, which has its natural residence in the intestine of the dog.

Though the hydatids or bladders may be occasionally found in cattle and animals of other species, the sheep is most commonly affected in Great Britain, and perhaps there is no disease which is more generally distributed. Lambs under a year old are more liable to be attacked than older sheep. As a rule, only a single sheep or a small proportion of a flock suffers from gid, but in rare instances very large numbers become the victims of the parasites. We have met with as many as 300 fatal cases in a flock of 350 lambs.

It has been known for very many years that the symptoms of "gid" depend on the presence of a bladder in the brain. Scientific research has not only revealed the parasitic nature of the bladder, but has traced out the life-history of the parasite, one phase of the existence of which it represents, and supplied the basis for rational measures of prevention. The mature parasites—tape-worms—have their homes in the intestines of dogs. Here eggs are produced and passed separately or within "segments" with the excrement. Some are deposited on grass or in water partaken of by the sheep. These eggs are microscopic in size, and after being swallowed are supposed to be carried through the blood vessels to the brain, where they are arrested. Here the egg develops into a bladder, which is filled with a watery fluid containing minute particles, which on microscopic examination are found to be the heads of tape-worms. Of

such heads a single bladder may contain hundreds. It is usual to find only one or two bladders in an animal's brain, though as many as nine have been met with. They vary in size from the smallest recognisable proportion to that of a goose egg. It is of some practical importance to realise that both the heads and the watery fluid are formed from the innermost lining, for while any of this remains, fluid and heads may form. If one of these bladders or heads be eaten by a dog, the tape-worm *Tœnia cœnurus* may develop in his intestine, and so the life cycle of another supply of hydatids or bladders be started.

The symptoms of "gid" depend on pressure of the bladder on the brain substance, and in degree of this pressure on increase in the watery fluid within the bladder. This pressure destroys the brain substance, and often causes bulging and absorption of the bones of the skull, so that the swelling may be readily seen, and the softness, usually at the forehead, felt with the fingers. These indications are only observable in the advanced stages of the disease. Gid is usually manifested by some peculiar movement or interference with movement of the animal, and the manifestation will much depend on the situation of the bladder in the brain. In different parts of the brain are so-called centres, which control certain movements or senses. If the bladder presses on that part on which vision depends, the sheep becomes blind, and so on. Blindness with very dilated pupils is not an uncommon effect. Perhaps the most frequent situation of the bladder is the front of the brain, the result being paralysis of one side of the animal, a tendency to move about in a circle, and softening and bulging of the bones of the forehead. When existing in other situations, the sheep may move with a high-stepping, trotting action, bound forward in leaps, or turn around on its hind limbs. Sometimes paralysis prevents the subject from performing any movements, and he continuously lies down. The head is frequently carried upwards or to the side. Interference with sight, hearing, and want of control of its movements often cause the animal to be separated from the flock. The sheep loses flesh and becomes very thin, and the termination is usually fatal.

The symptoms of "gid" are materially relieved by removal of the fluid contents of the bladder. It is a common practice among shepherds in some parts of the country to accomplish this by the operation of trephining, or the insertion through the softened bones of the skull of a trocar and canula. The former involves cutting through the skin, and by means of a specially made circular saw removing a piece of the bone of the skull, and withdrawal of the fluid and the bladder itself by means of forceps. Occasionally this operation effects a complete cure. Often it fails to do more than temporarily relieve symptoms, while not infrequently fatal termination is thereby hastened. From the simple puncture and withdrawal of the fluid, nothing more than temporary relief can be expected, as if the innermost lining of the bladder is not removed liquid quickly accumulates and the symptoms return. This procedure may occasionally be worth while, and allow of improvement in condition rendering the sheep fit for sale.

The prevention of "gid" is, however, what should be aimed at, and if attempted on the lines indicated by the life-history of the parasite, efforts in this direction are likely to prove successful. It must be borne in mind that if dogs harboured no tape-worm there would be no hydatids in the brains of sheep. Measures should be taken to prevent dogs from obtaining sheep's brains containing the bladders. The heads of all sheep affected with "gid" should be destroyed or rendered harmless by thorough boiling for some minutes. It should be a general practice to dose *all* dogs periodi-

cally with some medicine to expel tape-worms. Two or three daily doses of from a half to two drachms of freshly powdered areca-nut three or four times a year would probably effect the purpose. Great care should be taken to destroy any tape-worms passed. This is best accomplished by tying up the dog for a day or two after receiving his dose, and then burning the excrement and disinfecting the place. This procedure is quite practicable in the purely agricultural districts, where few dogs have access to the feeding grounds of sheep. It has been stated that other carnivorous animals (as foxes occasionally) harbour the *Tænia cœnurus*, but there is little evidence to show that "gid" of sheep is much affected through their influence.

Ginkgo, The, or Maidenhair Tree (*Ginkgo biloba*, formerly *Salisburia adiantifolia*), is the only surviving representative of a genus constituting the Natural Order *Ginkgoaceæ*. It was classed until lately as a conifer, but its nearest affinities are with the cycads and ferns. It is not known to exist now in a wild state, although it produces fertile seed abundantly, and is commonly planted near temples in China, Japan, and the Corea. *Leaves*, deciduous, fan-shaped with forked veins, 3 to 4 inches long and 2 or 3 inches broad, of a beautiful grass green. *Flowers*, diœcious; males in catkins, 3 to 6 on one shoot, pendulous, with numerous stamens, each bearing 2 to 4 divergent anthers, longitudinally dehiscent; females, 1 to 3, more or less erect on the shoot, each consisting of a long stalk which bears an ovule on either side below the apex. The ovule is naked, sessile, straight, surrounded at the base by a collar-like rim, supposed to be a reduced carpel. *Fruit*, a drupe-like seed consisting of a fleshy pulp, orange and very evil-smelling, within which is a woody shell enclosing the embryo with 2 or 3 cotyledons, embedded in albumen.

Although the ginkgo does not appear qualified for forest work in this or any other country, to the arboriculturist it is an exceedingly interesting tree, not only because of its beauty, which is of a very high order, but because it is a survival of the Jurassic and Eocene flora, and a contemporary of the extinct ichthyosaurs, deinosaurs, the toothed bird, and the four-toed horse. The timber is said to be fine-grained, resembling maple in grain, but not much valued in China and Japan.

The largest ginkgo reported from Japan stood, in 1884, just under 100 feet high at the temple of Kozenji near Tokio and 24 feet in girth. Dr. Henry, during his long sojourn in China, noted no specimens remarkable for size. In the British Isles, the ginkgo can only be pronounced perfectly hardy in the warmer districts. It stands any amount of cold it may encounter, but being very late of starting into growth, in ungenial seasons the annual shoots fail to ripen in cold or sunless exposure and die back to the old wood. It is a good tree for town planting, relishing the reflected heat from buildings and patient of polluted air, as may be seen in the main street of malodorous Brentford, where there is a pretty specimen on the south side of the pavement. A ginkgo at Frogmore, Windsor, was 74 feet high in 1904, with a girth of 9 feet 3 inches; but the tallest in England is at Melbury, Dorchester, over 80 feet high. Several others in the southern counties exceed 70 feet in height. In Scotland and Ireland this tree grows slowly, owing to want of sufficient sunshine; but there are several pretty specimens in various counties. The fern-like foliage, combined with a spraying habit, distinguishes the ginkgo from all other decorative trees. Dr. Henry states that the male is of more upright and pyramidal habit than the female, though Sargent denies that there is any constant difference.

Seed is easily obtained from Japan, and should always be made the means of propagation. The ginkgo transplants easily even when of considerable size, and stands pruning well at all ages. It is well to use the knife should one of these trees, as often happens, run to two or more leaders.

Glanders or Farcy.—Formerly glanders and farcy were regarded as two entirely distinct diseases. It is now absolutely certain that they are dependent on one and the same cause, of which they are merely different manifestations, or rather manifestations in different parts of the animal. As a disease of the horse, glanders has been recognised from very early times, and is referred to in many ancient writings. Aristotle and Vegetius mention it, and the latter was fully convinced that the disease was contagious. Fitzherbert in his *Boke on Husbandry*, published in 1523, and Markham in his *Masterpiece*, written in 1662, indicate the existence of glanders in Great Britain at those several dates.

Notwithstanding the teachings of Vegetius, the disease was up to a recent date held to arise by spontaneous generation and insanitary surroundings rather than from contagion. In 1882 the discovery of the microbe *Bacillus mallei*, the actual cause, settled this, and afforded proof that glanders and farcy were only varying manifestations of the same disease.

It is essentially a disease of the equine species (horses, asses, and mules), and though occasionally met with in flesh-eating animals as the dog, cat, tiger, lion, and other menagerie animals customarily fed on horse-flesh, and also in man, the infecting matter is almost invariably derived from an infected horse. In former times, that is, before the advent of railways, when public and private horse conveyances brought horses from all parts of the country into communication, glanders was more evenly distributed among town and country. At present, though cases were reported in 1906 from thirty-five counties, it is a disease of the town rather than the country, though occasionally serious outbreaks are experienced in rural districts.

By far the larger proportion of cases occur within the Metropolitan area. In 1898, 85 per cent. of the outbreaks occurred in London and the home counties. Glasgow is credited with a considerable number of cases. As the motor is coming into use and driving the town horse to the country, the relative number of outbreaks is less in London and greater in the country.

As to the nature of glanders, the very minute microbe or bacillus on which the disease depends, grows and multiplies at about body temperature, *i.e.* 100° F., and 10 degrees below this, 90° F.; so that it does not find suitable conditions in our soil or stables, whose temperature is usually very much below these points. Thorough drying and exposure to sunlight destroy it.

From the foregoing, as well as other points of observation, we may learn that glanders is mostly spread by glandered animals coming into association with healthy ones, rather than by contaminated stables, etc. The drier and lighter the stable, the smaller the chance of the germs living and remaining dangerous there. Of course anything soiled with recent discharge may be a means of communicating the disease. It is now thought that the germ of glanders is most commonly taken into the system through the mouth in eating or drinking. That form of the disease known as "farcy" usually follows entrance of the virus through some wound in the skin. It is also quite possible that the virus may be breathed in; indeed, until quite recently this was regarded as the usual mode of entrance. It has been stated that

thorough drying kills the bacillus, so that when in the form of dust it is probably harmless. Sometimes, however, a glandered horse may cough up moist matter in a very finely divided state, and this may be immediately inhaled by a healthy animal and set up the disease.

Glanders gains importance from the fact that man is liable to contract it, and that it often proves fatal to him. Probably the germ of the disease is most commonly introduced into the system of the human subject through a wound.

One of the most remarkable features associated with glanders is the fact that a horse may be very badly affected with the disease internally, and yield no appreciable evidence of it during life to the ordinary observer. Indeed, it is often quite impossible for the expert to say from an ordinary careful examination of an animal, if it be affected or not. Though in some cases there may be symptoms marked enough for formation of an opinion, no self-respecting person would venture to state that any horse, whose history he did not know, was *not* affected. It is the animal which is really affected, and yet showing no sign of the disease, that spreads glanders in a place, and from one place to others. Such a one may remain in a stable unsuspected while he infects a considerable number of his fellows. In other cases there may be certain indications, which should excite our suspicion or allow us to decide that an animal is affected. Of such the horse-owner is presumed by the law to have some knowledge, because he is liable to punishment if he does not report that such an animal is in his possession.

The symptoms vary a great deal, largely depending on the part of the horse's system in which the virus is operating, its numbers and activity. The following conditions should determine an owner or person in charge of a horse, ass, or mule to call in a veterinary surgeon, or to notify his suspicion to the constable nearest the place in which the suspected animal may be. A generally swollen limb, especially if there are small elevations, abscesses, or sores on it, the so-called "farcied leg," similar swellings in any part of the skin, or long tube-like swellings, "farcy pipes" having in their course small nodules or abscesses, when burst discharging an amber-coloured liquid, are suggestive of that form of glanders known as "farcy." Sticky discharge from the nostrils, or more particularly from one nostril only, a swelling, usually hard, painless, and well defined, between the branches of the lower jaw, sores or ulcers in the nostril, bleeding from the nostrils, are often regarded as typical of glanders. During the existence of those indications, the animal may feed well, lose flesh, have a generally unthrifty appearance, pass an increased amount of light-coloured urine, be easily fatigued, and cough more or less frequently. The foregoing have sometimes been described as "Chronic Farcy" or "Chronic Glanders." The malady may show itself in an acute form, in which extreme depression, high temperature, hurried breathing, great constitutional disturbance, and numerous abscesses, generally distributed over the skin, are associated with the above, and this is sometimes described under the head of "Acute Farcy." The general symptoms just described may be accompanied by much swelling in the space between the branches of the jaw, discharge from and ulceration of the nostrils—the so-called Acute Glanders. These acute cases generally terminate fatally in a few days at most. As a rule, the "glanders bacillus" produces small seed-like nodules in the lungs which do not evince much activity. It may, however, induce acute pneumonia or pleurisy, whose specific nature can only be determined after death, and then only by microscopic examination or inoculation of guinea-pigs, etc. Suspicion of the existence of glanders will, however, be materially affected by the

"history" of the animal under consideration, and this must include that of his stable companions; for, as remarked above, the animal which brings glanders to a fresh situation is by no means always the first to show signs of the disease. Nothwithstanding this, a horse may be affected with glanders and for a time, at least, not communicate the disease to horses in contact with him. Only animals discharging the bacilli are dangerous. It is, however, impossible to say when an animal may commence to discharge the germs, consequently it is highly important that every animal having the seeds of the disease should be removed from contact with others. This is only possible through the use of "mallein," which on being injected under the skin of a horse will tell with a high degree of certainty if it is the subject of glanders or not. It does no harm whatever to horses free from glanders. Though there is strong evidence that some horses recover spontaneously, in a large proportion of cases the disease sooner or later proves fatal. It is computed that glanders is responsible for an annual economic loss to Great Britain not much short of £100,000. In the eye of the law the disease is incurable, and at present an attempt is being made to eradicate it through the operation of the "Glanders or Farcy Order of 1907," which came into operation on 1st January 1908. Under this Order an owner must give notice to the nearest constable of having in his possession any horse, ass, or mule "affected" with glanders or farcy, or such as afford reasonable grounds for suspicion. For neglecting to do this, the owner is liable to heavy penalties. A horse, which reacts to mallein, though he shows no other sign, is regarded as "diseased." The Order also provides power to placard the entrance to places, warning the public, and to prevent movement of horses out of places in which there are "diseased" or "suspected" animals; and animals which have been in contact with "diseased" are regarded as "suspected" until they have been tested with mallein, those which react becoming "diseased," and those which fail to react as free from glanders. The local authority must slaughter "diseased" animals with all speed. The owner may appeal to the Board of Agriculture against an order of a local authority to slaughter, or against its decision as to the existence of glanders at post-mortem examination.

The Order provides for compensation at full value of the animal before being tested with mallein, not exceeding £50 for any horse, or £12 for any ass or mule, in cases where no evidence of glanders is found at post-mortem examination, and one-half of the value immediately preceding the mallein test, not exceeding £25 for every horse and £6 for every ass or mule which post-mortem examination shows to be affected; for animals "clinically diseased," that is, showing during life distinct signs of glanders, slaughtered under this Order, such amount as the local authority may think fit, the minimum being £2 for a horse and 10s. for an ass or mule; but in no case shall the amount exceed one-fourth of the value of the animal immediately before it became diseased. Other articles of the Order provide against exposure of affected animals, regulate movement, direct as to disposal of carcasses, and submission of orders of local authorities to the Board of Agriculture for approval or revocation.

For protection of his own interests and the public good it is clearly the duty of the horse-owner, on discovering grounds for suspecting an animal, to isolate it and give the required notice with all speed.

The present Order is brought into operation with a view of *eradicating* glanders, its adoption will entail considerable cost, and its success or failure will largely depend on the vigour or laxity of the local authorities on whom the duty of carrying out its provisions devolves.

Gleditsia.—A genus of the Cæsalpinioid branch of the Peaflower family (*Leguminosæ*), whereof one species, the North American honey locust (*Gleditsia triacanthos*, Linn.), thrives well in the United Kingdom, and would probably have been more commonly planted for ornament than it has been, but for the prevailing taste for coniferous trees. The honey locust is a tree 75 to 140 feet high, with slender, spreading rather pendulous branches. "*Leaves*, 7 to 8 inches long, 18 to 28 foliolulate, or sometimes bi-pinnate, with 4 to 7 pairs of pinnæ; leaflets lanceolate-oblong, unequal at the base, acute or slightly rounded at the apex, remotely crenulate-serrate, dark green and lustrous above, dull yellow-green beneath, 1 to 1½ inch long and ½ inch wide. *Flowers* appear in June from the axils of the leaves of previous years; greenish-white; staminate in short many flowered pubescent racemes 2 to 2½ inches long and often clustered; pistillate in slender, graceful, few-flowered, generally solitary racemes on stalks 2½ to 3½ inches long; calyx campanulate, narrowed at the base, the acute lobes thickened, revolute and ciliate on the margins, villose with pale hairs, rather shorter than, and half as wide as the erect, acute petals; filaments pilose towards the base; anthers green; pistil rarely of 2 carpels, hoary-tomentose. *Fruit*, a large pod 12 to 18 inches long, dark brown, pilose and slightly falcate, 2 or 3 together in short racemes on stalks 1 to 1½ inch long, their walls thin and tough, spirally contracted when drying. *Seeds*, oval, ⅓ inch long, separated by thick, succulent pulp" (Sargent).

The honey locust grows naturally on river-bank sand in valleys from the Alleghany Mountains westward to Nebraska and Kansas, and southward to Northern Alabama and Mississippi. Less frequently it is found on dry mountain land, and it seems fairly indifferent as to quality of soil. In France and Germany it attains a large size, and gives a grateful shade near dwelling-houses in the vine lands. It is a handsome tree, but it is seldom seen in Great Britain, though it is perfectly hardy, growing well and tall in the southern and midland counties. Sargent reports the timber to be "hard, strong, coarse-grained, very durable in contact with the ground, red or bright red-brown; largely used for posts and rails, for the hubs of wheels, and in construction." The honey locust is easily raised from its large seeds, the subsequent treatment being similar to that of the ash.

Glucose, or rather the Glucoses, are synonymous with the grape-sugars, and are classed generally with the sucroses or cane-sugars, the amyloses or starch group, and with gums, cellulose, dextrine, etc. The two principal varieties of the glucose group are dextrose or right-handed glucose, because it turns the plane of polarisation (of light) to the right; and an uncrystallisable syrup known as levulose, which turns the plane of polarisation to the left. Dextrose is found in many kinds of fruit, in manna and honey, and is often mixed with levulose. It also occurs in blood, in the white of egg, and, in small quantities, in healthy urine; but if in excess of the normal, it indicates the disease known as diabetes. It may be prepared by boiling starch or dextrine with dilute acids, by the action of malt upon starch, and by the action of dilute acids upon cane-sugar (*see* Dextrine).

Dextrose, or crystallisable glucose, is not nearly so sweet as sucrose or cane-sugar. In terms of energy or "full value" supplied to the animal, it is inferior to cane-sugar in the proportion of 3·7 : 4·0, but notwithstanding this slight inferiority glucose ranks with sugar as a nutrient. Dextrose and levulose (crystallisable and uncrystallisable glucose) are identical in chemical composition ($C_6H_{12}O_6$), and are carbohydrates (*see* article on this

subject). They are also almost identical in composition with cane-sugar ($C_{12}H_{22}O_{11}$). In the process of digestion the carbohydrates are converted by the saliva into cane-sugar (maltose, $C_{12}H_{22}O_{11}$), and further into dextrose and levulose.

Gluten (Glutin) is an albuminous body, and is described more correctly "as a mixture of various albuminous substances, which exist with starch in wheat grain." The chemical composition varies within somewhat indefinite limits, but is closely analogous to that of albumin, fibrin, and casein. It is the characteristic albuminous substance of wheat, and has been described as vegetable and wheat fibrin. It is also closely allied to animal gelatine, with which it has been confused. As neither gluten nor gelatine can be reduced to an absolute formula, it is impossible to define the precise difference between them; but gelatine is an albuminous substance derived from animal tissues, while gluten is a vegetable product of sticky, elastic substance, which can be drawn out into threads. Like all the albuminoids, gluten is approximately composed of carbon, 52·7 to 54·5 per cent.; hydrogen, 6·9 to 7·3 per cent.; oxygen, 20·9 to 23·5 per cent.; nitrogen, 15·4 to 16·5 per cent.; and sulphur, 0·8 to 1·6 per cent. The variations in composition have hitherto prevented the framing of definite chemical formulæ.

Glue is a form of gelatine, and the name is suggestive of gluten, to which it bears some resemblance. The two substances are undoubtedly allied to other glutinous materials such as isinglass and chondrine, but the vegetable origin of gluten removes it out of the category of glues and gelatines.

Gluten occurs in the deeper layers of the wheat grain below the cuticle, epicarp, endocarp, and testa, which together constitute the bran. Immediately below the testa is a fine membrane enveloping the square cerealin cells which occur between the bran and the endosperm, or interior of the wheat grain. The endosperm is divided into compartments separated from each other by layers of cellulose, and each of these compartments is filled with starch granules, embedded in gluten. The wheat grain is therefore a complex organism containing a germ provided with an embryo, plumule, and radicle, besides the layers of cells just enumerated.

The albuminous elements in wheat are composed of cerealin and gluten, which are sometimes treated as one. They are of great importance for purposes of animal nutrition, and the proportion of gluten gives what millers term "strength" to flour.

The wheats which are richest in gluten are grown in countries in which the summers are hot and the ripening is rapid. Wheats rich in starch are "weaker" than those rich in gluten, and it is customary to blend the two classes of grain in order to regulate the strength of the flour. Wheats rich in albuminoid materials are of "translucent" or horny appearance, while those richer in starch are "opaque" or less translucent, and are spoken of as "weak." Wheat which has ripened rapidly is less turgid than when fully packed with starch granules; and early cutting favours a high percentage of gluten.

The comparative value of wheats rich in starch or rich in gluten has often been discussed. Efforts have been made of late years to improve the quality of English wheats by introducing the strong wheats of Dakota, Minnesota, Colorado, Manitoba, and the North-west Territories. Similar and successful efforts are being made in America, by importing Hungarian and Russian wheats. It is found that the percentage of gluten can be increased by breeding, just as successfully as the proportion of sugar can be

increased by the cultivation of sugar-beet. In all these experiments the influence of environment is found to be very strong.

It is probable that the English climate is naturally more favourable for the development of bulky crops of the softer amylaceous wheats than the harder and more glutinous varieties. The harder wheats are produced in India, the United States, Canada, and Southern Europe, and these have been found to contain over 20 per cent. of gluten, while the softer English wheats only contain half that amount. The same is true of the hard wheats of Manitoba and the Western United States, where the proportion of gluten in the wheats grown rivals those of Southern Russia, Hungary, and the countries already named. The prices given for hard wheats, such as those of Minnesota, Manitoba, and Russia, appear tempting, but it must be remembered that Great Britain excels in bushels per acre, and that quantity may prove more profitable than quality in this particular case.

It is difficult to exactly compare the amounts of gluten found in different descriptions of wheat, as it may be calculated as proteids, moist gluten, or dry gluten. If we take proteids as the most practical standard, the proportion in the originally imported wheat from Hungary was 15·07 per cent. After once growing in California the proteid content was raised to 17·58 and 17·86 per cent.

The following extract from the Year-book of the Department of Agriculture, U.S., 1901, is significant as to climatic influence. "It is evident that in countries where the period of growth is prolonged . . . there would be a tendency to increase the amount of the starch in the grain at the expense of the nitrogen; while in the regions of short growth, such as Minnesota, the Dakotas, Colorado, and other northern latitudes, where the wheat is drilled in the spring, there would be a tendency to increase the protein (gluten) at the expense of the starch. There may, however, be marked departure from this rule. Lastly, there is no doubt that tailing wheat or corn which has gone off rapidly under forcing conditions is richer in gluten than normally developed wheat. In such cases a stronger wheat is obtained, but the increased percentage of gluten is due to an arrestment of starch development, and is therefore not necessarily an advantage, but rather the contrary. The fact is, both qualities of wheat are required in order to produce the best mixtures for milling, and although English wheats command less money, they are sadly missed by millers in bad seasons" (*see* Wheat).

Gluten is the fermenting agent in baking, stirred into activity by contact with yeast or leaven. Under the influences of fermentation, moisture, and heat, the amylaceous (starchy) constituents are converted into sugar, and this again splits up into carbonic acid gas, water, and alcohol. The evolution of carbonic acid throughout the mass causes the countless air spaces in light well-made bread, and this being due to gluten properly confers the name of "strong" upon wheats and flours abounding in this important constituent.

Goat, The.—The English goat is supposed to be sturdy, useful, and short-haired, with excellent milking properties; but if it was at any time distinguished by special properties these must have disappeared, for since the extended interest in goat-keeping in the last thirty years there have been many importations and in consequence many crosses, with the result that the goat, as it used to be, is seldom, if ever, seen. There are, however, many varieties of goat which are kept in a state of purity by

goat fanciers and breeders, some of which are beautiful in form, in coat and colour, while others are producers of large quantities of rich milk. Goats are most numerous and at their best in the mountainous countries of Europe and the East, and the following figures (1904–5) will show how largely they are kept:—

India (Bengal excepted)	24,874,000
South Australia	14,000
West Australia	21,000
Natal	908,000
Algeria	4,000,000
Argentina	2,748,000
Austria	1,019,000
Hungary	308,000
Belgium	241,000
Bulgaria	1,263,000
Denmark	38,000
France	1,476,000
Germany	3,329,000
Holland	165,000
Italy	1,800,000
Mexico	4,200,000
Norway	214,000
Roumania	232,000
Russia (Caucasus only)	6,975,000
Servia	432,000
Spain	359,000

There is practically no British goat which breeds to type, and the remark applies with equal force to Ireland and to Scotland, where goats are more largely kept, although they are generally inferior as milkers; the goats of Scotland being somewhat larger than the Irish breed. Goats are also kept in Wales to a somewhat large extent, although they are chiefly hornless. The English goat has been sometimes crossed with Nubian stock, a breed with rounded nose and long and drooping ears, possessing size and quality, when regarded as a milker. The Nubians for many years have taken champion prizes in the ring, and would be much more largely kept if they were more easily obtained. Mr. Bryan Hook, a good authority on goats, describes a famous Nubian, Ali Baba, with his wrinkled skin and protruding under-jaw, which rather suggests a "camel than a goat." His coat, he says, is short and close, and his colour uniform dark tan. This goat is hornless, though Mr. Hook believes this is not the case in general. He adds that he was imported in the autumn of 1891, and that "he has now survived long enough in this country to become acclimatised, and some of his progeny have already met with success at our shows. His history has probably been a curious one, for he is said to have been part of the loot brought by one of our regiments from the Soudan. At Cairo he fell into the hands of an itinerant showman, from whom he was purchased by the directors of the Jardin d'Acclimatation in Paris, whence he was obtained by Mr. Paul Thomas, and so reached this country."

Among the breeds of other countries are the Surats of India, and the short-haired reds of Southern Spain. These goats are horned, and though good milkers with splendid constitutions, their ears are pricked and

carried on coarse heads. Again, there are the Maltese goats, which are white or white and red, the coat being long, with almost horizontal ears, but they are found by those who have imported them and held them on their merits to be unsuited to this country.

Those who have visited Switzerland will have noticed that goats are kept on every mountain-side. The majority one sees are second-rate in character, although Professor Anderegg describes no less than sixteen varieties. There are, however, two or three Swiss breeds well known in England, the chief of these, the Toggenburg, hails from Canton St. Gallen. This is a mountain goat feeding at high altitudes, yet thriving well on English plains—a fact which is not surprising when we consider the quality of the food it gets.

The Toggenburg will thrive in paddocks or on roadsides, and while it carries little flesh it gives large yields of milk. The breed is hornless, and is clothed in a white rough coat with markings on the head. Its form is good, its constitution hardy. It is unfortunate that so few experiments are made to test the yield and quality of the milk of various breeds; the fat percentage and the total solids of an individual goat says nothing for the breed it represents. In order to arrive at the average yield of milk and the solids it contains, hundreds of samples should be weighed and analysed. The goats in many parts of Switzerland are taken to the higher mountains, like the cows, in charge of a single man, unless the herd is large, when he is provided with one or two assistants. The payment they receive is in proportion to the cows and goats they attend, or, as in some cases, where cattle are concerned and cheese is made, they draw their wages in proportion to the cheese produced for every owner.

The Alpenzell, another of the breeds of Switzerland, is a hornless, white-haired goat of excellent constitution, and a good milker. It may be here pointed out that the Swiss Government provides a subsidy to owners of male goats which reach a given standard. From time to time they are examined by a Government Inspector who selects the animals, the owners of which receive their proportion of the subsidy. This is one of the methods adopted in Switzerland for the exclusion of such cows as are not suitable, so far as form and pedigree are concerned, for improving milk production. At the National Agricultural Show in Switzerland no animal is permitted to enter for competition without passing an examination at the entrance to the yard; and it would be well if such a practice were adopted in this country, not only with regard to horses, cattle, and sheep, but to goats. One of the most beautiful varieties of Swiss goat is the Schwarzhals, which lives in the Valais. It is short-horned and has a shaggy coat, and almost runs at large in the mountains. It is largely bred in the neighbourhood of the Eggishorn. The Schwarzhals is large and strongly built, its colour is black and white, the latter being chiefly confined to the hindquarters, and it provides good meat for those who like it, but it is not one of the best of milkers.

Whether we are dealing with goats bred in the British Islands or with pure breeds from foreign countries, it is wise to be careful in making a selection; a milch goat should be large, her udder corresponding to her size, for it is found by experience that a large-sized udder means plenty of milk, indeed in many good milkers the udder reaches far back between the thighs, and causes the goat to walk in an awkward style on account of the appendage interfering with the movement of her legs. A good goat, too, has prominent eyes, ears which are rather large, while the horns

should be short or altogether absent. Some animals are of indifferent temper, and may cause damage to young children or even to adults, and yet there is this difficulty, that hornless goats are unable to protect themselves against aggressive dogs, which think twice before attacking a strong pair of horns. The coat, too, should be short and crisp, the constitution strong, and the pedigree, if any, full of details of the strain.

The goat has thirty-two teeth, but, like the sheep, has no incisors on the upper jaw; there are eight incisors in the lower jaw, and these assist the buyer in selecting a young animal. The first pair of incisors fall after the goat has reached a year, the second, third, and fourth pairs after each succeeding year has passed. These baby teeth are followed by permanent incisors, which fall out one by one when from seven to eight years has been reached, much depending upon the nature of the food which the animal has been consuming, and involving greater wear and tear. Thus when a goat has reached five years old she has a full mouth. It will also be noticed that the molars become worn as well as the permanent incisors, and thus it is well in making a selection that the teeth should be carefully examined. If it is possible in buying, females should be selected which are high at the shoulders and wide across the hips, with well-sprung ribs and long and level backs.

It is not often essential to keep a male goat, but where this is a decided point he should if possible be hornless, his body strong and well formed, and every point desired in the female developed more fully in the male. Breeders can always obtain information from the British Goat Society, which keeps a register of good breeding stock. The best periods of the year for mating are early in October or in March, while it is most convenient for the kids to be born in the beginning of March or the beginning of August. When goats are despatched by rail, as may be found necessary, they may be sent in crates or in wicker baskets made for the purpose; or in some cases, as the railway companies permit, with a collar and chain, but if a number are sent, the cheapest plan is to send them by the truck.

It is not easy to buy good milking goats, for they are none too common, and those who possess them are generally desirous of keeping them. But if an owner is willing to effect a sale, the greatest care should be observed in seeing the goat milked both morning and evening, and to take care that she has not been stocked for the purpose, or, in other words, that the milk of the previous day was drawn as usual. It is also important that she should be good tempered and easily milked. In some cases it is better to commence goat-keeping by purchasing a female goat or two from a good pedigree strain, while in all cases it is desirable, if the milk is required for the table, to keep two goats, so that one may be milking when the other is dry.

The figures in the table facing, which represent the production of milk with its percentage of fat and other solids, are the result of the competitions of the National Dairy Show at Islington during the past six years. They furnish an excellent idea of the richness of the milk, of the maximum and minimum yield of good specimens, and the great variation in the total solids and the fat.

It may be remembered by the reader that a gallon of milk weighs practically 10 lb. and a quart therefore 2·5 lb., and yet in the above list of selected goats in only one case is 3 quarts reached, while in only five instances in six years' competitions were 2 quarts reached, the figures

being based, as we have seen, upon the average of two days. Again, it has frequently been stated that the milk of the goat exceeds 7 per cent. of fat. It is true that these figures are frequently exceeded, but it is important that those who study the question for themselves should know that while 7 per cent. is sometimes reached, there are only ten cases in these competitions in which 5 per cent. is exceeded out of sixteen, the fat in one instance reaching only 2·88 per cent. We may therefore take it for granted that the fat percentage of the milk of the goat is higher than that of the milk of the Jersey cow, but we can scarcely say so much for the solids other than fat, by which we mean the casein and the sugar.

The milk yield of a goat is too small to be worth the trouble of making into butter, but goat-keepers, as a rule, regard it as equal to the butter of the cow, in spite of the fact that it is white. With this we can scarcely

Goats' Milk.		Yield and Quality.		Average of Two Days.	
	Prize.	Weight of Milk. Lb.		Mean per cent.	
		Morning.	Evening.	Fat.	Other Solids.
1901 . .	1	3·0	2·6	6·88	9·10
,, . .	2	2·8	2·3	4·95	8·70
,, . .	3	3·3	2·6	4·79	8·81
1902 . .	1	1·5	1·2	7·67	9·75
,, . .	2	2·9	2·1	6·68	9·07
,, . .	3	2·3	1·8	4·02	8·71
1903 . .	1	1·5	1·1	6·70	9·76
1904 . .	1	1·1	0·9	7·19	9·44
,, . .	2	2·1	1·7	5·18	8·92
,, . .	3	1·6	1·4	4·73	9·21
1905 . .	1	3·8	3·8	3·75	8·24
,, . .	2	2·0	1·9	6·20	9·27
,, . .	3	2·0	1·8	5·65	9·29
1906 . .	1	2·25	1·75	5·54	9·43
,, . .	2	3·7	3·45	2·88	8·16
,, . .	3	1·25	1·25	5·62	9·03

agree, although it is not likely to become a marketable article. The cream can be extracted by the separator or by the system of scalding as practised in Devonshire. The writer has attempted to produce a useful cheese, but the quantity of milk produced is much too small for manipulation. The tiny cheeses made in Switzerland and Italy are eaten by the peasants, and are practically unfit for the table of the ordinary public. There is, however, no reason why, if goat-keeping were a more important industry, experiments should not be made with the object of producing a tasty form of cheese like Bondon, Neuchatel, Gournay or Camembert, even though it became necessary to remove a portion of the fat.

It is estimated that in Savoy the average goat yields 300 litres, or about 66 gallons, of milk where a number of head are kept, and this after it has fed its goatlings for a month. As in Switzerland, this milk is frequently used for making into cheese, realising 6d. to 7d. a pound in the mountain

districts, where the people are poor and few in number. A well-made goats'-milk cheese in Savoy is worth at least 6d. when made from 2 pints of milk. Goats' milk is indeed used for cheese-making during some seven months of the year in parts of the mountainous districts, but greater care is exercised in the feeding and management, as in their selection for breeding. In one part of the Jura 130,000 lb. of cheese were made in a recent year, which realised an average price of 6d. per pound, while in the following year the price obtained was 8d. Again, in Mont d'Or, which gives its name to a famous cheese in France, the number of goats kept for many years was 11,000, while the average yield of milk reached $2\frac{1}{4}$ litres per day, or about 2 quarts. There has, however, been a diminution in the number of the flocks, as it was found by farmers that they could make an equally good article with the milk of the cow in quantities equal to the increased demand, which they could not do with goats'. A French writer speaks of an instance in another district where a small herd of twenty-four goats annually produced forty-eight kids and yielded about 14,400 litres of milk, a litre being equal to $1\frac{3}{4}$ pint, and 13,850 cheeses, with the result that a profit of 100 per cent. was realised.

There are many persons who implicitly believe that Gruyère is a goats'-milk cheese; but it should be needless to add that it requires the milk of a large number of cows to make a single Gruyère. The flavour of the milk of the goat depends very largely upon the character and quality of the food consumed. A goat of a good variety is equally at home on the mountain-side, in the paddock of an English owner, or in a stable, so long as she is well supplied with grass or hay and other foods which are used for milk production. The richness of the milk, except for its butter and cheese-making properties—and, as we have seen, that feature is but little considered—is somewhat diminished in value as a fluid food unless it is diluted. The quantity of fat renders it unsuitable as a beverage, and especially for young children. For example, a sample containing 7 per cent. of fat which is sometimes present would produce—on the basis of the system adopted in the production of butter from cows' milk—about 1 lb. of butter to 13 lb. of milk, so that a person taking a quart of goats' milk per day would consume from this source alone a considerable quantity of butter. Where invalids are placed upon a milk diet, 2 or 3 quarts a day are by no means uncommon quantities, and it will not be supposed by the simplest reader that so large a quantity of butter could be assimilated in such a case even by a healthy person. Where goats' flesh is consumed, except in the case of very young kids, the meat is taken from the carcass of the female, and it is not surprising that in some parts of the world, as in the valleys of Switzerland, which are excluded from the outer world during the heavy snows of winter, that goats provide a large proportion of their food. We are inclined to think that goats' milk is of greater value to the public than its advocates believe, for if an animal is well selected and produces milk of the highest quality, its quantity volume can be doubled by the addition of water, although the nitrogenous matter, which we know as casein and albumin, like the sugar, would be diminished in proportion; we are speaking solely of the richness of the milk in fat. Sugar could be added from the table, or the pure milk could be increased in quantity by the addition of the separated milk of the cow, which would make it an almost ideal food. It is claimed by an authority upon the goat that while cows' milk contains an average of 3·6 per cent. of fat, the milk of the goat contains an average of 7·3 per cent.; but we fear the latter is too high a figure. The same authority recommends the use of goats' milk

as a food for infants, for the reason that it contains no germs of tuberculosis; but, as we have seen, its richness entirely precludes its usefulness in this direction unless it is specially prepared. If a comparison is made between the milk of the goat and human milk, it will be observed that the fatty contents of the one are three times as large as in the other case. If goats are really free from tubercle and indeed immune, although the facts are not exactly proved, it were well if they were more generally employed for feeding infant life and invalids, but only when diluted with cows' milk which has been skimmed.

In spite of the hardy character of the goat and the extent to which it is exposed on its native mountains, it needs both care and shelter, with the best of food, if it is expected to produce a large yield of milk in the hands of English breeders. We can scarcely believe that goats are kept as pets and for no other purpose, but that those who spend money upon their food and management do so with the single object of obtaining milk, although no doubt in many cases something may be ascribed to that love of animal life which is so prominent a feature in the British race. The goat is supposed to feed upon all varieties of food of a vegetable character—on weeds, on hedge clippings, on the roadside herbage, the waste of the kitchen and the kitchen garden, as well as upon those costly foods which are supplied to milking cattle.

Whether when out of doors they should be allowed their liberty is a matter for their owner to determine, but they take great delight in barking trees and trespassing on the neighbour's land, however strong the hedge. Steps must therefore be taken to prevent these depredations. If there are trees they must be guarded, while if hedges are imperfect the goats must be tethered, or a flat barred fence erected through which they are unable to pass their heads. If neither plan is carried out, it may be found essential to fix a triangular collar on the neck, a device which is understood by almost all goat-keepers. If it is decided that the goats should be tethered, they should be removed to a fresh piece of ground two or three times a day, for goats do not thrive on land which they have long occupied. A goat is tethered by a lightish chain from 10 to 12 feet long, one end attached to an iron stake looped at the head and driven into the ground, the other to the leathern collar of the goat.

A goat possessing freedom obtains a variety of foods, as on its native hills; and this is an advantageous plan, for change is good for man and beast. Many of our readers will have noticed how fond they are of gorse and the tender heads of thistles, indeed there are few weeds which they reject. While summer is the time for freedom when goats cost little or nothing for the food they eat, it is in winter when the cost is felt. Unless some hay is grown at home it must be purchased like the corn and meal. Goats must be fed, and fed with liberality, if they are expected to yield a good supply of milk. Among the best of foods are hay, oats, maize, crushed wheat and barley, sweet bran, and sometimes ground peas or beans. As with the cow, there is no better food than oats and bran, 1 gallon of each providing a liberal feed per week; but where acorns are obtainable, sufficient to provide a pint a day, these foods may be reduced. Another excellent ration is a mixture of maize, oats, and peas, all crushed or scalded in equal parts, with all the hay the goat requires when given in small quantities from time to time. Among our succulent foods are brewers' grains, carrots, parsnips, and mangel-wurzels, chopped fine, together with the produce of the garden in almost all varieties, including the haulm of peas and beans, potato parings, and other waste provided by the kitchen;

indeed in many cases the kitchen waste will save the cost of meal and grain.

We have remarked already that goats need shelter and good housing. In part owing to their pugnacity each goat should have a stall partitioned from her neighbour; its width should be narrow, to prevent her turning round; on one side of the stall an upright rod is screwed to give sufficient play when the goat is tethered by the chain, which is fastened by a swivel to her collar. The floor may be of chalk or beaten earth, well littered with straw or fern, though some prefer the bottom to be bricked and grooved. Some goat-keepers cover the floor with wooden spars, which are removed for cleansing when the goat is out, but the objection to this method is that wood is an absorbent, and in spite of litter it is quickly fouled and stained. Fronting the stall is a small manger for the corn and meal, with a rack above for hay. Great care is taken by experienced men to prevent the soiling of the food, which goats at once reject.

Where kids are reared by hand, they should be allowed to take milk from the udder during the first three days; subsequently it will be found better to draw it off by hand and teach the kid to drink, unless it is too rich, when it may be slightly diluted with skimmed milk or water. At the end of ten to fourteen days a little well-cooked linseed gruel may be added to the milk, the quantity of which should be reduced. Again, in two or three days' time the quantity of gruel may be increased, while the milk may be diminished, and so on until at twenty days when they commence to feed. No trouble should be spared or care avoided in feeding the female kids of valuable goats, and yet it is a curious fact that a good milking goat provides more milk than a pair of goats require. Should one of her new-born pair prove to be a male that is not needed, the best plan is to destroy it before it robs the house of milk, unless in summer, when the food costs nothing after the first fortnight, and even then the value of the kid may not be equal to the milk supplied. It should be remembered that as kids need more food in winter in the form of grain or meal and hay, there should be no hesitation in destroying them or giving them away in order to avoid the cost. When kids are weaned in spring they are so precocious that they quickly feed themselves, at little cost to their owner. From spring to autumn is the better time for milk production, though warmth and liberal feeding, especially with linseed cake, will help the yield in winter. During the winter season the milking goat should especially be kept from cold and wet. She should be milked twice daily whether she has kids or not, and as far as possible twelve hours apart. As in the case of cows, the udders should be stripped, for where milk is left behind there is a tendency to decrease the yield; apart from which the last milk is the richest.

When kids are born the goat should be at liberty within a paddock or a fenced enclosure, or kept within her box or stall, but never tied, until the kids are born, when she may be supplied with a warm bran mash or oat-meal gruel made in a half-liquid form. For the first three days the milk is too abnormal to be fit for home consumption, containing, as it does, too much albuminoid matter.

The period of gestation in the goat is from one hundred and fifty to one hundred and fifty-four days, or about five months. The best times for mating from September to March, but useful dates are about the 1st of October and the 1st March, that where two goats are kept the milk supply may be regular. Some goats will pair at any time, and in many cases quite young goatlings evince the desire, seeking the male if he is within easy reach, and displaying other symptoms which can be gathered

from anyone accustomed to goats. For the purpose of crossing with a male of special breed or quality, the best plan is to despatch Nannie a few days before the dates decided upon, and leave the matter in the hands of the owner of the male. A female should not be allowed to breed until she has reached the age of eighteen, or, better, twenty months, as her growth will be all the greater and the stronger. As a rule, two goatlings arrive at each period of parturition, and these can be easily reared by the dam; but sometimes three appear, and this is one too many. When parturition is expected, the udder enlarges, but usually a few weeks beforehand. This is a sign that the udder should be dried, as a further milking robs the kids of strength and value.

Gorse.—The gorse, furze, or whin (*Ulex europæus*) belongs to the sub-order Papilionaceæ of the natural order Leguminosæ. It is distributed over the greater part of central and southern Europe, and it also occurs in the Canaries and Azores. In Britain it inhabits commons and waste ground, ascending to over 2000 feet above sea-level.

The gorse forms a more or less rounded bush, averaging about 5 feet in height, with hard and spiny branches almost devoid of leaves. In the seedling state the plants have trifoliolate leaves, but in adult life the leaves are mostly reduced to scales, and the leaf functions are almost wholly performed by the green shoots. The flowers, which commence to appear in February, or even earlier, are borne on the spines, and are about $\frac{3}{4}$ inch long, of a bright yellow colour, and highly scented. The calyx is deeply two-lipped (*bilabiate*), the upper lip having two and the under three minute teeth. The filaments of the stamens are united into a tube (*monadelphous*), and the style has a capitate stigma. The seedpod (*legume*) is about $\frac{3}{4}$ inch long, black when ripe, and opens along both edges (*sutures*). In dry, warm weather the pods rupture with great force, producing a crackling sound.

Formerly the uses of the gorse were of some importance, and in agriculture it played a not unimportant part as a forage plant; in fact, in Brittany and Normandy it has been used from time immemorial as fodder for cattle. It has also been used for live fences and for shelter to plantations, and it forms fine fox cover. But the agricultural merits of the plant have been much overrated, and, excepting on dry sandy wastes, where little else will grow, it is of little value. The only part of the plant which is useful for fodder for stock is the young green shoots, and when these are properly prepared by crushing, and a suitable proportion of other food given, both horses and cattle can be maintained upon them during winter, while sheep will exist upon the shoots alone.

Various appliances for crushing the young shoots have been devised, the simplest consisting of a mallet, having cross-blades on one face and the other flat, and a block. The shoots are laid on the block and chopped into lengths by means of the cross-bladed end of the mallet, and completely crushed by means of the flat end; and in the various kinds of mills which have been invented for preparing the shoots the action is either one of simple crushing (the shoots having been previously cut into lengths), or a combination of cutting and crushing. Gorse mills are now, however, practically obsolete in Britain, and, excepting for the food it affords to sheep in severe weather in winter, and the slight shelter which it produces on exposed ground, the plant itself has now no place in agriculture.

There are several varieties of *Ulex europæus*, the principal being the Irish furze (*U. europæus*, var. *strictus*) and the double-flowered whin (*U.*

europœus, var. *flore pleno*). The Irish furze has much more erect-growing and more slender branches than the type, and it is considered more valuable as a fodder plant; but unlike the type, it does not come true from seed, and, having to be propagated by cuttings, it is therefore much more troublesome to the cultivator. The double-flowered variety is of some importance in horticulture, making an excellent subject for planting in the wild or semi-wild garden.

Although native to Britain, the gorse is not quite hardy, and in severe winters it is sometimes killed down to the ground level.

Gout Fly.—*See* Corn and Grass Pests.

Government Loans for Land Improvement.—*See* Loans.

Grass Crops.—The outstanding importance of grass crops will be readily seen when it is remembered that nearly one half the total area in the United Kingdom is under these crops. Of the total area of land and water in the United Kingdom there are about 12½ million acres under grain and green crops, while there are nearly 6 million acres under rotation grasses and over 28 million acres under permanant pasture. As the different grasses and clovers vary greatly in quantity and quality of yield, a correct knowledge of the grasses and clovers is of the first importance to the agriculturist. In this work the different grasses and clovers are all referred to under their proper headings, and the subject will be further dealt with in the article on Permanent and Temporary Pastures.

Grass Moth.—*See* Antler Moth.

Grease in Horses.—This condition, technically known as *Seborrhœa*, is happily much less common at present than formerly, a fact probably due to the greater care and intelligence generally exercised in the management of the farm horse. The disease is an inflammatory affection, involving the skin at the back of the pastern and fetlocks, and sometimes higher up the leg. It more frequently affects the hind than the fore limbs. One limb is more often involved than a larger number, and though in severe cases there may be some constitutional disturbance, it is evidently a local affection, rather than the local manifestation of some general disease. Grease has acquired some additional interest from the fact that Jenner, who introduced "vaccination" against smallpox, stated his opinion that it was in some way related to cowpox—the disease of the cow's udder, from which the "vaccine lymph" was obtained. We know of no evidence pointing to such a conclusion, though there is reason for thinking that different diseases have been described under this heading, and certainly one of these possesses many of the characteristics of the class to which cowpox belongs, but not so the condition now being described. Grease may possibly occur in horses of any class or type, but is rarely found in any other than the coarser "gummy" legged of the class. It is undoubtedly more common in animals of the heavier than those of the lighter breeds.

Cause.—The immediate cause of the changes in the skin has not yet been satisfactorily demonstrated, though it would appear to be most commonly associated with dirt, to which the back of the hind legs of horses are so liable. Many observers attribute grease to improper feeding, especially with highly stimulating food; others to a sluggish circulation. It is, however, certain that, if properly searched for, a mange mite of a variety which almost invariably confines its attack to the extremities, may be very frequently discovered. By some authorities this parasite (*Acarus symbiotes*) is regarded as the exclusive cause of grease. Its presence, however, is not always discovered, and it can scarcely be accepted as the sole cause of all the changes observed, for certain characteristics could not be scientifically attributed to the action of an *acarus*, but call for the intervention of some much more minute organism possessing the power of disintegrating matters. The disagreeable odour emanating from a "greasy" leg is highly suggestive of the action of some micro-organism. It may, however, be taken for granted that anything which favours the accumulation of dirt at the heels, or debilitates the skin there, favours the residence of both *acari* and bacteria, and this is sufficient for all practical purposes.

Symptoms.—The appearance of grease may be comparatively sudden. The first sign may be stamping of the hind feet, or rubbing of the legs with the shoe of the opposite limb, which causes bleeding. The leg becomes swollen, hot, and tender. Usually at the heel or fetlock first, there is a profuse weeping of transparent or opaque oily fluid, which hangs in droplets on the hairs which tend to become matted, and this is accompanied by a disagreeable, fetid odour. Owing to the pain of the swollen part the horse may now be very lame, and may continue in this state for several days, during which, if the swelling is very acute, there may be a considerable degree of fever. The discharge, which is believed to emanate mainly from the grease glands of the skin, is in some cases so copious that it runs down the leg and irritates the skin of the heel, causing it to be "cracked." After a variable time the acute process appears to subside, heat and pain of the swollen part pass off, but the swelling remains, and the discharge becomes rather thicker. Elevations now occur on the skin, which assume an appearance which has given rise to the name "grapes." These excrescences are composed of blood vessels at the base, and sebaceous matter (firm greasy material), etc., at the summit. If injured, "grapes" bleed profusely. In chronic cases of grease, the limb becomes permanently thickened, and though a horse may work with comparative ease with the enlarged leg, even while it is exuding fetid matter, the condition renders an animal very unsightly and disagreeable, and of comparatively small sale value.

Treatment.—Careful stable management tends to the prevention of this affection. Long standing in stalls without exercise encouraging a sluggish circulation in the hind legs, accumulation of dung in the stable, washing the legs and not thoroughly drying them, should be carefully avoided. Whenever there may be any suspicion of a tendency to grease, the thorough cleansing of the legs from the hock down, and application of one of the dressings mentioned below are indicated. The hair should not be clipped from the fetlocks of specially coarse-legged horses. As regards curative treatment, it is most important that this should be adopted immediately, and carried on vigorously, for the great aim is to avert the chronic form of grease. It is, in the majority of cases, wisest and most economical to obtain the services of the surgeon as early as possible. A strong dose of purgative physic, thorough washing with soda, soap, and water, and, after drying, the application of some antiseptic ointment or lotion, which should be frequently

repeated, and tonic medicines internally, appear called for in a large proportion of cases, and a moderate diet allowed. It may be necessary to surgically remove the excrescences or grapes, and this is usually done with a hot iron. Neglect to deal promptly with this affection usually means a troublesome case, which never quite recovers to normal, and leaves the animal much depreciated in every way.

Green-crop Manuring.—Reference to Fallow Crops will show that the entire advantage of growing such crops lies in the fact that they are mostly consumed upon the holding. This may be without delay, as in the case of a root crop eaten upon the land by sheep, or, less immediately, where the roots, although removed from the field, are returned in the form of farmyard manure. In green-crop manuring live stock are excluded, and the crop is simply ploughed in. In seasons of superabundance, root crops have often been crushed with a Crosskill roller, and then ploughed under; and in other cases clover or rye have been similarly treated when not needed for sheep. This is practically green-crop manuring.

The theory of this system of management is quite intelligible and consistent with the advantages of feeding the same crops upon the land. It rests upon the fact that when a crop is eaten by live stock, the bulk of the ingredients of the crop are returned to the soil in the liquid and solid excrements; but when the same crop is ploughed in, the whole of the ingredients of the crop are so returned. The balance of advantage lies on the side of ploughing in, so far as the manurial value of the crop is concerned, because, although the animal does not retain a very large proportion of what passes through its intestines, it retains some of the most valuable manurial constituents. Growing sheep, for example, extract phosphates and nitrogenous matter from the herbage on which they feed. They also assimilate carbohydrates and fats, but these may be passed over as having no manurial significance. They supply nothing that they are not simultaneously extracting from their food, and assuming for the sake of argument that they are living entirely upon the vetches, turnips, or other crop upon which they are folded, the land is robbed through the nutrient constituents which the animals retain. It is therefore clear that the land suffers to some degree from the crop being consumed, and that it would not thus suffer if the crop were returned intact. This is the theory of ploughing in fodder crops instead of feeding them off by animals, but it by no means exhausts the *rationale* of the system of green manuring. It might, for example, be questioned whether there can be any advantage in returning a crop to the soil which has been produced from the same soil—whether it is not merely restoring what has been taken out. It also leaves out of account the profit which may accrue from feeding animals, and both points require consideration. We shall take them in the order in which they are stated. First, then, as to whether a green crop ploughed in adds to the fertility of the land? It certainly does so by the vital action of the growing crop. The roots penetrate to a considerable and practically unknown depth, some, as for example those of red clover, having been traced vertically to a depth of 54 inches (Rothamsted Papers). Others penetrate to a less depth, but in all cases the roots are collectors of plant food from both the surface soil and the subsoil, and elaborate the materials they collect in the bodies of the plants composing the crop. These fertilising ingredients are all returned to the surface soil when the crop is ploughed in, and as they decay they render back the fertilising elements in

an available condition. The advantage is very considerable, because much of the success of the succeeding crop depends upon its first start in life. The surface soil is enriched even if the total of soil and subsoil taken as a whole is not, and the material is ready for assimilation without the plant labouring for it. The first stimulus is therefore given, and as the roots of the young crop gain in strength, they are the better able to penetrate the subsoil and find fresh stores of food. The mass of carbonaceous matter, which is not of great value manurially, is beneficial to the soil mechanically; and the whole of it is returned, instead of only a large proportion. Some farmers attach importance to the excrementitious nature of dung and urine, but this will not stand scientific criticism, as the only criterion of the manurial value of every description of food is its composition, *minus* what the digestive processes remove for purposes of nutrition. If we approach the subject from an analyst's point of view, it is obvious that the food before it is eaten contains a larger quantity of fertilising matter than can possibly be returned in the excrements. Neither does it appear that excrements are of greater value than the decomposed remains of a crop ploughed in. They are quicker in action, it is true—that is, they require less time to completely decompose, but this objection may be obviated if sufficient time is allowed between ploughing in the crop and seeding the ground again.

As to the second question, namely, whether more profit may not be made by feeding a green crop than by ploughing it in? it really does not affect the main question. It may readily be granted that it is, or should be, more profitable to pass the green crop through animals, and the question of green-crop manuring will scarcely arise when there is sufficient stock to consume the herbage. It may, however, be advisable to extend the growth of green crops, with the object of ploughing them in, beyond the requirements of stock. In some seasons there is a natural superabundance of green food; and it may be advisable to elaborate a system of growing green crops, with the prime object of ploughing them in.

There is a point not yet touched upon, namely, the advantage of the consolidation of the land by sheep. This is, of course, very important, but it only applies to some classes of land, and there are others upon which treading acts injuriously. It may also be urged that fodder crops are not fed alone, but with an admixture of cake and artificial foods. Both these points are of importance, and help to explain the great advantage of fallow crops and sheep farming. There is no antagonism or rivalry between the two systems of consumption by stock and green-crop manuring, neither is there any reason why they should not be both followed upon the same holding.

We shall next consider various cases in which the ploughing in of green crops is to be recommended. The writer calls to mind the evident benefit to a wheat crop of his own due to ploughing in a strong plant of red clover at a time when keep was unusually abundant. It was done early in the autumn, and the mass of green stuff was allowed time to rot, and the furrow was well rolled after ploughing. The plan of sowing clover upon oats or other corn with the express purpose of ploughing in the growth in the autumn is now much recommended in America as a means of storing up nitrogen in the soil. If the growth is luxuriant, the land may thus be enabled to produce a second corn crop the succeeding year, and the idea is suggestive of other means of securing the same result. In this country clover may be sown too often, and one objection against the suggestion is that land so treated might show signs of clover

sickness at a later period. If, instead of sowing clover on the young corn, white mustard were broadcasted over a tilled stubble, immediately after harvest, a strong growth might be obtained within six weeks, and this could be ploughed in with similar benefit. The peculiar power of the clovers to abstract nitrogen from the atmosphere is not forgotten, but the writer believes that mustard or any other green crop is able to collect nitrogen and hold it in organic combination. Nitrogen is inseparable from vegetation, and whenever there is free and abundant growth it is present in abundance. Whether it is obtained from the atmosphere, or pumped up by root action from the lower layers of the soil, or collected from the soil itself, are less important considerations than that it should be present in organic combination, and no longer be liable to be washed away in the form of soluble nitrates (*see* Farmyard Manure). A mass of vegetation ploughed in is equivalent to a dressing of farmyard manure, and is already spread uniformly over the surface without labour. If 10 tons per acre of fresh vegetable matter can be obtained by growing it on the field, it must be better than having to cart it from a distance.

The system of growing white mustard on fallows may be adopted with excellent effect, and will not only enrich but clean the land. Mustard is the most rapid growing of all the crops which we possess. It may be sown in April or early May upon fallow ground, and will be ready to plough in by midsummer. The ground can be again seeded on the freshly turned furrow without delay, and a second crop of mustard will be available for the same purpose at harvest time. The land may then be a third time sown and the produce ploughed in, and thus three crops of mustard may be ploughed into the same field in one season. The method and the results of this system were described by Mr. Peter Love in the fourth volume (2nd Series) of the R. A. Society's *Journal*, in which he stated that not only was the ground made rich for wheat, but that every root of couch was killed, and the land rendered perfectly clean. The growth of the mustard was in some cases so luxuriant as to necessitate rolling and special appliances in order to bury it, but when once ploughed in it rapidly decayed. In the same volume are papers by Mr. G. Murray and Mr. W. S. Wright upon the ploughing in of such green crops as mustard, spurry, buckwheat, lupines, and turnips. Among more recent contributions to the subject there is *Farming with Green Manures*, by C. Harlan, M.D., published at the Friends Printing House, Philadelphia, which in 1888 had reached a 4th edition. Hungarian millet, clover, rye, buckwheat, mustard, and turnips are all named as suitable green manures. The latest author who deals extensively with the subject is Professor Edward B. Voorhees, Director of the New Jersey Agricultural Experiment Stations, and Professor at Rutgers College. In his excellent book on Fertilisers, Professor Voorhees deals with green manures as "nitrogen gatherers."

He lays stress upon the power of growing crops to prevent the leakage of nitrates through the soil. When nitrogen exists in a soil in the form of nitrates, it is especially liable to be washed out by rain, but as long as it occurs in combination with vegetable matter it is safe. It is one of the functions of growing crops to seize upon nitrates and hold them in organic combination, and to yield them up gradually in the form of nitrates as they die and decompose. The action in green manuring is therefore conservative as regards nitrogen. A field which is covered with a natural carpet of green in the autumn has already yielded up its floating supply of nitrates to the innumerable rootlets which extend as a mat beneath the

surface. Such a field is in all respects better placed for retaining and adding to its stock of nitrogen, than one which lies bare and exposed to the winter's rainfall. This is one of the strongest reasons for sowing autumn catch crops on stubbles. It bears strongly upon the subject of green manuring; for such catch crops are quite as useful when ploughed down as when eaten on the land by sheep. In these remarks the writer has not quoted experiments, but rather endeavoured to explain the principles of green manuring. They are applicable to all classes of land, that is, both light and heavy. On the former, organic matter is always beneficial, as it increases the power of the soil to retain moisture and fertilising matter. On the latter, it improves the texture and mitigates the tenacity of the staple, by introducing organic matter in large quantities. A vigorous growth of any crop is also opposed to weed propagation, and the ploughing in of green crops, while they are in full vigour, offers a direct means of preventing weeds from seeding.

Ground Game Act.—*See* Game Laws.

Grub in Grain Crops.—*See* Corn and Grass Pests.

Grubbers.—Grubbers take various forms, and local nomenclature renders it impossible to definitely distinguish them from other forms of cultivator (*see* Cultivators), but most generally the term is applied to narrow cultivators suitable to work drill rows of roots, or else to those which have a specially strong frame, and carry a stout body or more than one stout body, to which broadshares or other points may be attached. However, in some districts the term is applied to any implement which breaks up land and stirs it other than the plough.

The smaller grubbers are often called single row cultivators or horse-hoes, as they are frequently used to clean root crops, potato crops, etc., where the drill rows are wide apart. Some types which are fitted with a body can be conveniently converted into moulding-up ploughs, broadshares, or combined broadshares and stirrers. These small grubbers take many shapes, and may consist of a simple beam carrying handles, the beam being supplied with crossbars to which tines or hoes are attached; or may be of more elaborate form with expanding frames, which may be made to contract or expand at will, so that the hoes they carry may cover the width of any row in which they are required to work. As these grubbers are light in weight, and easily jerked out of the straight when working, it is very important that they be well balanced, that the tines or body are set at a good pitch, so that they readily draw into hard land and run evenly and steadily, otherwise there is great risk that they will cut up the crop; moreover, if much pressure is required to hold the tines down so that they may face their work efficiently, the draught is greatly increased. In hard work, as, for instance, among beans, where the soil has become hard set, it is very desirable that the leading tine or share point should be chisel-shaped, so that it will not have a tendency to be turned out of its course by stones, but will cut its way through. Grubbers should be provided with attachments which permit the stems of the hoes being readily adjusted in width and depth. The back tines should also be of a shape which admits their points freely into the ground; in the more modern

grubbers advantage is taken of the reversible steel points now used on the sickle-tine cultivators, and these do good work.

Among small grubbers those of the type of the Planet Jr. have taken a prominent place in recent years, and from their effectiveness they are likely to maintain their popularity, as they are light in construction and draught, easy to steer, readily adjustable, and effect thorough working of the land under all condition; as they can be fitted with a large variety of points and shares, they are suitable for working in all widely drilled crops.

The hop grubber or shim was until recently a narrow implement suitable for working between hop-hills, but clumsy, relying mainly upon its weight to effect the deep stirring demanded by the crop; the adoption of the sickle tine has, however, been taken advantage of in recent years with marked success.

The older types of grubber are fast disappearing before the lighter and more effective sickle tine cultivator, and their disappearance marks an advance in agricultural engineering and farm practice. The old broad-shares were heavy in draught, lacked the vibrating motion of the spring tine, and the land was less effectively stirred by them.

Grunting in Horses.—Grunting, as applied to horses, is a sound emitted during a sudden expulsion of air from the lungs through the nostrils. This, like most other sounds in respiration, is produced by the larynx at the top of the windpipe. Most animals, including man, are liable to grunt when suddenly startled, and the horse is usually tested for the production of "grunting" by a feint being made to strike him with the hand, a stick, or whip, sometimes by suddenly bringing a rider's heels to the animal's sides. An animal which, on application of the test or without any appreciable startling, audibly grunts is termed a "grunter" or a "*bull*."

By many horsemen and veterinary surgeons, grunting is regarded as *ipso facto* an unsoundness. Equally strong opinions are held by others equally, if not better, qualified to hold them, that grunting *per se* is not an unsoundness. As an alleged cause of unsoundness, "grunting" is not infrequently before our courts of law for settlement. If unsoundness be taken in its ordinary interpretation, *i.e.* some defect which at present interferes or is likely at a future time to interfere with a horse's usefulness, it is difficult to comprehend how grunting can be brought within the category, for of itself it does not interfere with the work of an animal. There is, however, no doubt that "grunting" has a certain significance, for while in some cases it is nothing more than a habit of an animal, which he may sooner or later lose or retain through a long life during which his "wind" remains perfectly sound, it is frequently observed in horses which are "roarers" or "whistlers," or which become the subjects of this form of unsoundness. "Grunting" may therefore be regarded as an act which frequently precedes or accompanies "roaring" or "whistling," and it may reasonably be the ground for refusal to purchase a horse; but while some animals grunt and never become "roarers" or "whistlers," "grunting" of itself cannot properly be held to be an unsoundness. While it is justifiable to refuse to purchase a horse which "grunts," on account of the risk of its becoming a "roarer" or "whistler" and thus unsound, if a grunter, on being put to the usual and proper test of "galloping for wind," makes no abnormal *inspiratory* sound (*see* Whistling), he cannot be properly described as at present "unsound in

wind." Long and extensive experience in the examination of horses for soundness indicates that by far the larger proportion of horses which habitually grunt, are "roarers or whistlers," or become so, but also that in some cases there is no such relation. There is great variation in the "sound" of grunting, some horses yield a deep, sonorous, prolonged note which at once suggests paralysis of the larynx, and on galloping almost invariably proves to be an accompaniment of "roaring"; other grunts are followed by a sharp, shrill inspiration, which is on galloping proved to be that of a whistler. The "grunt" is emitted by some horses only in performing some special movement, as taking a fence or dropping from it, in turning to right or left, in backing, etc. It may be indicative of some pain or discomfort experienced in such acts and arising from some internal abnormality, or only of a special nervous state of an animal.

Guano.—Under the name of guano (Spanish Huano) are included at least two types of manurial substances; the first being produced in dry climates, where rain seldom or never falls, and the other under moister circumstances, or even where the original deposits have been washed with sea-water.

The first class are rich in salts of ammonia, while in the latter the phosphatic element predominates. To the popular mind the ammoniacal guanos from the Chincha Island, Ichaboe, and Peru, represent guano, and the more so as the phosphatic guanos are hard and compact in structure, as, for example, guanorite, and require grinding and mixing before they are applied to the land.

Guano appears to have been first introduced into Europe by the distinguished naturalist von Humboldt in 1804, and soon established itself as a potent fertiliser. We cannot pause to give a detailed history of its progress, but its achievements caused a remarkable sensation in agricultural circles, and were even celebrated in song. The merits of Peruvian guano are due to its highly nitrogenous character, combined with great richness in phosphates. It is entirely produced from the dung of sea-fowl, which has accumulated under a dry climate for an enormous period of time. This deposition is still in progress, but Humboldt observed that in even three hundred years only an insignificant thickness was produced, and that the deep layers of 50 and 60 feet in thickness point to accumulations through long ages. The excrementitious origin of guano is alone sufficient guarantee of its value as a fertiliser, without having recourse to analysis. When it is remembered that the sea-fowl which produce it live entirely upon fish, and that the dung accumulates without any admixture of "litter," it is easy to understand its high value. The digestive system of birds entails the expulsion of the solid and liquid excrements together, in a semi-fluid state, the white portion being largely composed of uric acid. This tends to preserve it, and present the dried matter in an available condition. Guano of this description is snuff-coloured and pulverulent. It is free from grit or sand, and smooth when rubbed between finger and thumb. It weighs about 40 lb. per bushel, and does not emit a pungent odour, although it has a distinct and characteristic smell. It should be dry, but if damp, like Bolivian guano, it smells strongly of ammonia, due to the decomposition of uric acid. This is not a recommendation, as it entails the loss of one of the most valuable ingredients, although erroneously thought by many farmers to be a sign of superior quality. The true test of the nitrogen content can only be arrived at by analysis, and the less pungent

guanos will generally be found to be the richest in ammonia-salts and nitrogen.

The value of the Peruvian guanos consists in their richness in nitrogen and phosphates, and this is due to the composition of the fish on which the birds feed. Fish only contains about 2 per cent. of ash or mineral matter, but 15 to 17 per cent. of nitrogenous substance, associated with some 20 per cent. of oil and 64 per cent. of water. The oil is appropriated by the birds for purposes of nutrition, and does not appear in their excrements at all, so that among other excellent features in guano (in which it excels fish manures) is its freedom from greasy or oily matter. Of the ash ingredients of fish, phosphoric acid composes about 40 per cent., and potash about half that quantity. Still, 40 or 20 per cent. of 2 per cent. is not a high proportion to the total weight of a fish; and the consequence is a larger proportion of nitrogenous than of mineral matter, and a distinct poverty in potash. A high proportion of potash or of "alkalies" in a Peruvian guano must in fact be regarded with suspicion, and points to the fraudulent introduction of common salt.

The guano first imported into this country was much richer in fertilising ingredients than those guanos now placed upon the market, although exceptionally excellent samples are still to be found. The deposits are far from being exhausted, and guanos still form an important section of the special fertilisers used in agriculture. It has, however, ceased to be so generally used as formerly, having met with a large number of competitors, such as nitrate of soda, salts of ammonia, and phosphatic manures, as, for example, superphosphates and basic slag. Guano figures sparingly in the Rothamsted experiments, probably on account of its uncertain composition, and the greater reliance that can be placed upon manures of definite character for experimental purposes.

Composition of nitrogenous guanos.—There are many analyses published, as see the Reports of the Consulting Chemists to our leading Agricultural Society, Dr. Aikman's excellent work on *Manures and Manuring*, Warington's *Chemistry of the Farm*, and many other works. The earlier analyses of Way, Voelcker, and continental chemists indicate the richness of the earlier worked deposits, while those of later years show some marks of deterioration. Thus the earlier richness in ammonia-salts is shown by the presence of from 34·6 to 52·57 of urates, oxalates, phosphates, muriates, and sulphates of ammonia, coupled with from 28 to 38·69 per cent. of phosphates of ammonia (common to both), magnesia, and lime. If we now turn to later analyses, we look in vain for those high percentages of the two leading plant nutrients. Reduced to terms of nitrogen, these older guanos contained about 14 per cent. of nitrogen [nitrate of soda contains 15 per cent.] and 12 to 14 per cent. of phosphoric acid, equal to 26 to 28 per cent. soluble phosphate of lime. The recent importations frequently contain only 3 to 4 per cent. of nitrogen, but tend to become richer in phosphates. The principal sources of nitrogenous guanos of the Peruvian type occur in Patagonia, Falkland Islands, Saldanha Bay, Ichaboe, Angamos, and Guanape Island.

Besides the above sources of this valuable fertiliser, bat-guano has been found in Mexico in enormous quantities, produced by myriads of bats, which for long ages have made their abode in caves.

Phosphatic guanos form a distinct class, which, although originally produced in the same manner as the ammoniacal guanos, have lost a large proportion, if not all of their nitrogenous organic matter, through exposure to rain and sea-water, and been reduced to a hard, shelly character. These

guanos are in many cases compact and rocky in texture, and require to be disintegrated and treated with sulphuric acid, in order to reduce them to the condition of phospho-guano, or of high-class superphosphates. They contain 70 to 80 per cent. of insoluble phosphate of lime, but are not suitable for direct application to the land. The principal sources of the phosphatic guanos occur in certain islands in the Pacific, among which may be mentioned Baker, Enderbury, Browse, Huon, Chesterfield, Sharks Bay; also Mejillones, Bolivia, Kuria Muria, Maracaibo, Sombrero, Curaçao, and many other places. They contain from 30 to 40 per cent. of phosphoric acid, and therefore rank among the richest sources of this fertiliser.

Application of guano to crops.—The nitrogenous guanos alone are fit for direct application in their native form, and are peculiarly suitable for the purpose. They are pulverulent, dry, and therefore easily distributed by hand, or by mechanical manure broadcasters. The principal difficulty in recommending them is their wide difference in composition, and no manure requires to be analysed more than guano. The fame of guano was celebrated in serio-comic verses sixty years ago, each ending with the refrain "From the famed Ichaboe," indicating the original source and its wide popularity. Peruvian guano was held in the highest esteem from 1850–60, especially in the north of England, where experiments on the growth of roots showed that no fertiliser could compare with it at equal price per acre. The climate of the North and West, including Ireland, exactly suited it, as the moisture caused the decomposition of the highly complicated ammonia salts which it contained. The system of raised ridges, split over the manure, was also exactly suited to it, as it insured a thorough mixing with the soil, and prevented the guano from being brought into direct contract with the seed. It was also found to be an admirable top-dressing for oats, wheat, and grass land, as might be expected from its composition. Various results were published, some of a sensational character, but they are not reproduced here on account of the uncertainties of soil and seasons, which so easily falsify results obtained under special circumstances.

The quantity applied is usually about 2 cwt. per acre for corn. It may be used alone, but it is better mixed with superphosphates. It is largely used in potato cultivation, and the quantity used is then greater. Four cwt. of guano, 4 cwt. of superphosphate, and 2 cwt. of sulphate of potash would not be considered an excessive dressing for potatoes, as the inevitable expenses of "sets," cultivation, and storing are heavy, and a heavy yield is therefore necessary. It is frequently used in large quantities per acre for hops, and is an ideal manure for this crop, as it is rich in phosphates and nitrogenous substances (*see* Hops). Mangel-wurzel is another crop to which guano may be applied with advantage. It is effective upon all gross feeding crops capable of producing heavy yields per acre, such as cabbage and Italian ryegrass.

Peruvian guano never gained the same footing in the southern counties as in the north, partly on account of the dryness of the climate, and partly because of the system of drilling manure and seed together with combined drills. There is no doubt that the Peruvian types of guano exert an injurious effect upon the germination of turnip seed, as the author of this paper pointed out (1872–74) in his reports upon experiments conducted in Gloucestershire on an extensive scale. The general result was, that on an average over the entire series, the number of swede plants produced on $\frac{1}{20}$ acre plots manured with 3 cwt. per acre of Peruvian guano, was 497, as compared with 818 plants produced by superphosphate alone, and 662 by a

mixture of guano and superphosphate. The effect was always easily seen on inspection, as the guano plots showed a somewhat irregular plant of roots of larger size and carrying luxuriant tops; while the superphosphate plots produced a regular plant of less size, and with smaller tops. Similar effects were produced by an application of nitrate of soda drilled with the seed, but no such effect was observed on mangel seed, owing to its thicker integuments, and the natural partiality of the plant for nitrogenous dressings.

Guano not being in request in the south, it requires to be specially ordered, whereas superphosphate is always kept in stock by every dealer in artificial manures. Peruvian guano, although an animal excrement, is not a general manure in the same sense as is farmyard dung, as it is deficient in alkalies. Dung, on the other hand, is rich in potash by virtue of the large proportion of straw which it contains.

Guano has been more frequently adulterated than many other fertilisers, on account of its natural origin. It is frequently associated with sand and worthless mineral matter. Water has frequently been added, largely because of the prejudice on the part of farmers in favour of a strong smelling substance. Moisture causes decomposition of urates and other organic salts of ammonia, and produces carbonate of ammonia or smelling salts, which gives the impression of strength, whereas it really means a direct waste of nitrogen. Salt has often been added as a means of raising the proportion of "alkalies," too readily assumed to be potash. Sawdust, chalk, gypsum, and sulphate of magnesia have been often used as adulterants. Under the name of guano, a number of inferior substances, although not fraudulently described, but nevertheless indicating the importance of analysis, are annually imported. Guano has been treated with sulphuric acid as in Messrs. Ohlendorff & Co.'s patent in 1864. The object is to fix the ammonia and dissolve the phosphates, and the mass is reduced to powder by disintegrators and sold as "dissolved guano." Phospho-guano is produced by the action of sulphuric acid upon phosphatic guanos, and the same material is largely used in the manufacture of high-class superphosphates.

Guernsey Cattle.—The Guernsey cow, one of the most useful of milk and butter breeds, is not so largely bred in England as the Jersey. It is possible that the reason is that she is less attractive, but she is largely bred in the island from which she takes her name. In weight she varies from 900 to 1000 lb., and yields an average of some 500 gallons of milk per annum, which, like that of the Jersey, is rich; the fat percentage averaging 4·55 per cent. and the other solids 9·25 per cent. It is, however, most remarkable that the Guernseys differ largely in their yield. Some of the deepest milkers produce as much as the best Jerseys, but taking the Guernseys in the aggregate their yield during these later years is less. There are many Guernseys which have exceeded 1000 gallons in a year, but, on the other hand, there is a much larger number which scarcely pay their keep; and yet the breed is one of great capacity and possible development. The admirers of the Guernsey cow in England are much fewer in number and much less energetic than the breeders of the Jersey. The restrictions on the score of points are not so numerous, whereas the greater size of the Guernsey should tell immensely in her favour. She is usually more fleshy in the carcass, and steers which are bred and fed for beef are not to be despised; such steers we seldom find among the Jerseys. The heifers, if well fed until near calving, are usually so rich in flesh that doubts

Parsons.

GUERNSEY BULL.

Parsons.

GUERNSEY COW.

may be dispelled as to the capacity of the breed for meat production, and although it cannot be compared with butchers' stock, it only needs encouragement by crossing for that purpose. And yet the Guernsey is above all a dairy cow, and should be bred on dairy lines.

The following are the points of the Guernsey breed in accordance with the standard of the English Guernsey Society:—

Scale of Points (Adopted October 1905) for Cows.

1.	Head fine and long, muzzle expanded, with wide open nostrils, eyes large with quiet and gentle expression, forehead broad, horns curved, not coarse	5
2.	Long thin neck, clean throat; backbone rising well between shoulder blades; chine fine	5
3.	Back level to setting on of tail, broad and level across loins and hip, rump long, thighs long and thin, tail fine reaching to hocks, good switch	5
4.	Ribs amply and fully sprung and wide apart, barred large and deep, with strong muscular and navel development	15
5.	Hide mellow and flexible to the touch, well and closely covered with fine hair	5
6.	Hair a shade of fawn with or without white markings; cream-coloured nose	3
7.	Size—Cows, four years old or over, about 1000 lb.	10
8.	Escutcheon wide on thighs, high and broad, with high ovals	2
9.	Milk veins prominent, long and tortuous, with large and deep fountains	8
10.	Udder full in front	8
11.	Udder full and well up behind	8
12.	Udder of large size and capacity, elastic, silky, and not fleshy	8
13.	Teats well apart, squarely placed, and of good and even size	8
14.	Skin yellow in ear, on end of tail, at base of horns, on udder, teats, and body generally; hoofs amber-coloured	10
		100

For Bulls.

1.	Head fine and long, muzzle expanded, with wide open nostrils, eyes large with quiet and gentle expression, forehead broad, horns curved, not coarse	5
2.	Long masculine neck, clean throat; backbone rising well between the shoulder blades: chine fine	10
3.	Back level to setting on of tail, broad and level across loins and hip, rump long, thighs long and thin, tail fine reaching to hocks, good switch	15
4.	Ribs amply and fully sprung and wide apart, barrel large and deep, with strong muscular and navel development	15
5.	Hide mellow and flexible to the touch, well and closely covered with fine hair	5
6.	Hair a shade of fawn with or without white markings; cream-coloured nose	3
7.	Size—Bulls, four years old or over, about 1500 lb.	12
8.	General appearance, vigour, style, alertness, and carriage; hind legs not to cross or sweep in walking	15
9.	Rudimentaries squarely and broadly placed in front of and free from scrotum	10
10.	Skin yellow in ear, on end of tail, at base of horns and body generally; hoofs amber-coloured	10
		100

Although the standard provides for a fine and lengthy head and fine curved horns, the average cow is coarser in these points than the average Jersey, nor is she so fine and slender, possessing, as she does, a larger frame, covered with a thicker skin, with want of elegance in shape and colour. Of later years Guernseys of the finest form have now and then been shown at some of the largest shows, but the numbers have fallen off considerably,

displaying want of interest in the breed. At one of the island shows which we attended, the champion cow produced more milk and butter than any Guernsey which as far as we remember has been tested in an English show, while in another case a Guernsey was exported to the United States which made a record which has seldom been excelled.

Among the highest yields of milk and butter fat the following may be mentioned:—

	Year's Yield of Milk.	Year's Yield of Butter Fat.
	lb.	lb.
Princess Rhea, 5282	14009·89	775·69
Hayes Rosie, 4092	14633·08	714·31
Itchen Daisy 3rd, 5153	13636·80	714·10
Charmants of the Gron, 3636	11874·76	676·47
Itchen Beda, 4110	10642·10	548·72
Bilberry 3rd, 4701 (seven years old)	10339·00	...
Rosey, 2308 (average for fifteen years)	7764·00	...

It may be pointed out that as a hundred pounds of milk is about equal to 10 gallons, the cows Princess Rhea and Hayes Rosie each yielded over 1400 gallons within the year, while in each case the weight of butter would be 850 lb. and 748 lb. respectively, inasmuch as butter contains from 12 to 15 per cent. of water.

The following figures refer to the measurements of a champion heifer of two and a half years old which the writer took at one of the London Dairy Shows:—

	Inches.
Height at hips	50
Length	86
Girth round middle	91
Girth at shoulder	72
Across hips	18
Hip to tail	18

When we reflect upon the wretched yield of an average English cow, what can be said of the skill and the enterprise of her many thousand owners?

From the point of view of money value the result in the cases quoted is quite remarkable. The value of butter in Guernsey Island is greater than in England, but taking its English price at 1s. 3d. in winter and 1s. 1d. in summer, we may fairly place it at an average of 1s. 2d. a pound. Thus the butter alone in the case above would be worth £39, 10s., while the separated milk and butter milk would add to this sum another £8. Thus we get a return of £47, 10s. per annum, without including the value of the calf, which in such a case would be much more than usual.

The Guernsey, like the Jersey, is not kept for the sale of milk, but rather for the production of butter, and thus it is that the standard tells, as well as the feeding properties of the breed. The average farmer who produces milk for sale prefers the dairy shorthorn; first on account of her larger yield of milk, next because of her meaty carcass and her suitability for fattening for the butcher, and lastly because of the greater value of her calves. The milk of the Guernsey being so rich is seldom placed on the market and yet it is more economical to buy such milk and to slightly dilute it with water, because in its pure condition it is much too rich in fat for the ordinary consumer.

The relative popularity of the Jersey and the Guernsey in relation to the system of public testing may easily be shown. For example, since 1897 to 1906 inclusive the number of Jerseys tested was 193, while the number of Guernseys reached only 41, the highest number in any year being 8, in 1901. From 1895 to 1906, 45 Guernseys were tested, the average days in milk in the first five years being 71$\frac{3}{4}$, while in the last few years, in which only two or three cows competed, it was 165 and 138 days. The average weight of butter in the first five years was 1 lb. 9$\frac{1}{2}$ oz., against 1 lb. 10$\frac{1}{4}$ oz. for 126 Jerseys, the butter ratio in the latter case being 19·15 lb., while for the Guernseys it reached 21·6. In only one year, of twelve referred to did the Jerseys exceed a ratio of 20 lb. of milk to 1 lb. of butter, while in every year but 1905 the Guernseys exceeded 20 lb., reaching in 1903, when five cows competed, 27$\frac{3}{4}$ lb. Thus far the Guernseys have taken a much lower place than the cattle of the sister island; on the other hand, they are superior to any other breed.

Another point of great importance is with reference to the producing powers of the Guernsey at different periods of lactation, and here some figures may be quoted from the *Journal of the British Dairy Farmers' Association.*

GUERNSEYS.

	No. of Cows.	Days in Milk, 50.	No. of Cows.	Days in Milk, 100.	No. of Cows.	Days in Milk, 135.	No. of Cows.	Days in Milk, 190.
		lb. oz.		lb. oz.		lb. oz.		lb. oz.
1895 to 1900 .	3	1 7$\frac{1}{3}$	4	1 7$\frac{1}{2}$	3	1 4$\frac{5}{8}$	1	1 8
1901 . .	1	1 15$\frac{1}{4}$	2	1 5$\frac{3}{4}$	...	...	2	1 8$\frac{5}{8}$
1902 . .	...	...	...	...	...	...	...	...
1903 . .	2	0 15$\frac{1}{4}$	...	...	...	...	...	...
1904 . .	2	1 6$\frac{3}{4}$	...	...	1	2 0$\frac{1}{2}$	...	...
1905 . .	1	1 10$\frac{1}{2}$	...	...	1	1 12$\frac{1}{4}$	1	0 13$\frac{1}{2}$
1906 . .	...	...	1	1 1	1	1 5$\frac{1}{2}$	...	...

Here the Guernseys, taking the aggregate, fall far below the Jerseys, but it is important to observe that the number of cows referred to in this particular matter is very small. On two occasions only comparisons were made between the butter churned and the fat as shown by chemical analysis. In one case the butter weighed 1 lb. 1 oz., while the total fat was 1 lb. 5$\frac{1}{4}$ oz. In the second case the butter churned weighed 1 lb. 5$\frac{1}{2}$ oz., while analysis showed the milk to contain 1 lb. 8 oz. of fat. The figures are too small to make any fair deduction, but it is obvious that butter containing 12 to 15 per cent. of water should have weighed much more than the butter fat alone, although in these two cases it was much lighter. If, however, we take the results of nine years' comparisons we find there are still serious discrepancies, as the following figures show:—

Year.	Churn.	Analysis.
1898	8·07	8·25
1899	5·90	5·53
1900	10·84	11·10
1901	12·46	11·59
1902	1·23	1·34
1903	5·34	6·47
1904	4·89	4·94
1905	3·42	3·42
1906	2·41	1·82

In the year 1901, when eight cows competed, the average yield of butter was almost precisely what it ought to be, but in six other years the pounds of fat as shown by the analyst were higher than the pounds of butter churned. These are facts of great importance, for in every case the yield of butter by the churn should be at least from 8 to 10 per cent. higher than the weight of fat as shown by analysis. If we make a comparison between butter and the butter fat, as applied to the Jersey breed, we find the matter altogether different. In every case the butter weighed the most, while in six of the nine instances adduced, applying to a similar set of years, the butter weighed more than could have been expected.

Now let us turn to another feature of the Guernsey as a milker. Where cows compete it is essential that they should reach a standard. To-day the standard for Guernseys is 85 points, while for the Jerseys it is 95; no prize can be awarded in the milking trials if these figures are not reached. From 1903 to 1905 the standard of points for Guernseys was 90. In 1903 six cows were tested, but failed to reach the standard; in 1904 only one of seven was successful; in 1905 only one in five; while in 1906 only three out of six exceeded 85 points. These figures, too, are low by comparison with Jerseys, although the standard of this breed is higher.

Although the Government standard for milk for sale, which must reach at least 3 per cent. of fat and 8·5 per cent. of other solids, only two cows exhibited during sixteen years failed to reach 3 per cent., while from 1902 to 1906 only one cow failed to reach 8·5 per cent. of solids not fat. And here again the Jerseys held the first position, for in accordance with their numbers the failing cows were fewer. Let us next deal with the quantity and quality of milk as produced by the Guernsey cows exhibited from 1900 to 1906.

Average Composition of Milk.

Period.	No. of Cows.	Weight of Milk.	Fat per cent.	Solids other than Fat per cent.	Total Solids per cent.
1900–1904 . .	36	lb. 31·5	4·58	9·07	13·65
1905 . . .	5	31·4	4·81	9·15	13·96
1906 . . .	6	34·5	4·42	9·29	13·71

It will be noticed that in every case the milk was rich in fat as well as in other solids, but while they were far below the Jerseys, these beat every other breed in quality, although, the Kerry cows excepted, they were lowest of all in quantity. In 1906 the Guernseys' average yield of morning's milk was 17·9 lb., while the evening's reached 16·6 lb. These figures were slightly above the Jerseys, but far below the shorthorns of both classes, the Ayrshires, the Devons, and the crosses. The difference in the yield as between one breed and another may be shown by the fifteen dairy shorthorns, which gave an average in the morning of 23·7 lb. and in the evening of 23·6 lb. Although in the majority of cases the milk was rich in fat the quantity was small, the first prize-winner alone producing an average daily yield of over 4 gallons. Thus it is that the Guernseys have fallen in character and in quality, but now that great efforts are being made to establish a first-class Butter Test, we

have no doubt that in two or three years the Guernsey breed will run the Jersey hard; for, as we have already shown, its capacity for the production of milk and butter is extremely marked.

The position of the Guernsey cow in Great Britain depends to a large extent upon the Guernsey Club and the regulations which that Club has drawn up. The following are a few of the most important rules, which we have condensed for the convenience of the reader. A knowledge of these facts is indeed essential to all who are interested in the Guernsey cow. No animal is eligible for the English Herd Book which cannot trace its pedigree on the side of both sire and dam to imported stock, while no animal which has been imported after the 25th March 1885 is eligible for the English Herd Book unless it is registered in the Guernsey Island Herd Book and can produce certificates to that effect. The offspring of animals disqualified under the operation of this rule are themselves ineligible. The Society binds itself never to enter any animal of whose purity of lineage they have the slightest doubt. A payment of ten guineas constitutes a member for life, an ordinary member paying a guinea per annum. For the registration of stock members are charged 2s. 6d. per animal entered, and non-members 10s., but no application for entry will be entertained if the subscription is overdue. The owner of a registered bull shall give to the owner of the cow a dated certificate, which shall be sent to the secretary at the time of registration of the produce. All members who desire to enter stock must make a return at the end of each year of the birth of all calves born alive or dead during that year on official forms. The owner of any animal, or of the descendants of any animal, tested under the regulations of the Society or of the Royal Guernsey Agricultural Society, shall be entitled to have the figures representing the result of such test in pounds and ounces inserted after the name of the tested animal whenever the name appears in the Herd Book of the Society.

The Guernsey Society in providing a Home Test Register has produced a set of rules and regulations which we condense as follows:—The object of the register is to record the weight of milk with its percentage and weight of butter fat produced by cows and heifers, which equal or exceed the following record, within seven days.

Animals under two years old to produce 10 lb. of butter fat, adding ·00456 for each day over two years and under three years. Thus, a three-year-old cow would be required to produce 11·6644 lb., and a four-year-old cow 13·3288 lb. This rate will be continued until the animal is five years old, when the amount required will have reached 15 lb. of butter fat in seven days, this being also the production required from cows over five years.

The register will be published in the Society's Herd Book, but not unless the animal tested is owned by a member of the Society. The test must extend over seven days, commencing not less than fourteen days after calving; each animal to be milked two or three times a day. On application for a test a member will be required to pay 10s. for each animal and to fill up an official form of application, also to pay the travelling and hotel expenses incurred by the official appointed to make the test. Tests must commence at any time upon giving ten days' notice on the official form, but the Society cannot in all cases guarantee to conduct a test on any given date. No condition powders or drugs of any kind may be given to the cows, but dry foods may be mixed and softened with water, but with no other liquid. The official appointed will see each cow milked the evening before the commencement of the test, at the same hour fixed for the milking

during the test, and must himself strip her perfectly dry. He must subsequently be present at each milking. He must weigh the milk on each occasion on a Sandringham Recorder, and note the weight on a form supplied, subsequently determining its percentage of fat by means of a Gerber tester, supplied by the Society, and furnish a complete record to the Secretary within seven days of the completion of the test. Only one cow can be milked at a time. The tests are to be under the general direction of a Committee of the Society, who may alter or amend the conditions, and decide all other matters.

With regard to the average yield of milk from Guernseys in America the following facts relating to a herd of twenty-five will afford some useful information. The yield varied from 600 to 950 gallons per cow per annum. The minimum percentage of butter fat was 4·28 per cent., while in one instance, and that the chief, the butter produced reached 587 lb. Another cow produced 546 lb., and in several other instances from 400 to 500 lb. The cow which gave the highest yield of butter produced 8988 lb. of milk in 321 days, showing an average of 1·83 lb. of butter per day when milking, or 1·61 lb. per day during the whole of the year.

One of the most marvellous cows ever tested was exported to the United States. She was born in Guernsey in 1896 and bred in the Island. The object of the owner was to place her in the Advanced Register of the Guernsey Club, and in order to accomplish this it was essential that the cow should produce 1000 gallons of milk containing 360 lb. of butter fat. Her yield of milk was 1180 gallons, while it contained 676 lb. of butter fat, showing an average of 5 per cent. The milk was poorest in quality in the month after calving, but in January of the following year it reached 6·12 per cent., and subsequently fluctuated between 5·6 and 6·1 per cent. The period of lactation was unusually long, for it was not until after a year had passed since calving that the milk yield fell materially. In this case the work of testing was conducted by the officers of the New Jersey Experiment Station, so that we are bound to accept as perfect truth the statement made. It was estimated that the butter fat yielded was equivalent to 789 lb. of butter, showing an average yield of 2·16 lb. per day throughout the year. This cow consumed, apart from grass and hay, silage and mangels equal to 8 lb. per day. The chief foods employed were bran, 1726 lb., and gluten, 836 lb., together with smaller quantities of maize, linseed and cotton seed meal and middlings, a highly nitrogenous ration. During the grazing season of summer she fed upon lucerne, maize, green oats, clover, and peas. One of the largest herds which we remember to have seen was on the estate of the Vice-President of the United States some distance up the Hudson River. The herd numbered some 200 head, and, if we remember aright, was kept on business lines for the supply of butter to the market of New York. The Guernseys have done excellent work in many of the States, and we may here refer to a few of the important rules relating to the admission of imported Guernseys into the American Herd Book.

Certificates from the breeder and the seller of imported Guernseys must be supplied to the Secretary of the Club. On the back of each certificate must be a sketch, made before shipment, of all white markings on each animal, and certified by the breeder and the seller. There shall also be stated therein the name and residence of the breeder, the name and residence of the importer, the date and birth of the animal, the sex, the Island or English Herd Book name and registered number, and the Island or English Herd Book name and registered number of the sire and dam of the animal offered for entry if the same are registered, as they must be if living on the

Island at the date of execution of such certificate. If the imported animal be in calf, the owner of the serving bull shall affix his name to the breeding certificate with name and registered number of the serving bull and date of service. The Secretary of the American Herd Book is required to brand on the hoof of each animal its Herd Book registered number, and to obtain the name of the ship importing the cattle, with the port and date of landing, which will be filled in after the certificates are opened by the Secretary, and they shall remain in the office of the Club as evidence of importation. The names of English or Island breeders of imported stock shall be printed in the American Herd Register with the names and Island or English Herd Book numbers of their sires and dams, unless such sires and dams are already in America and eligible for entry. The breeder or seller of a cow for exportation to America is required to append a sketch of each side of the animal, the head and the shape of the horns, with its sex, name and number, and distinguishing colour and markings.

In America it appears that Guernseys may be fawn or white, red or orange, yellow fawn, orange fawn, lemon fawn, light red, brown, or brindle. In this country, as in the Island, Guernseys are practically all orange or lemon, orange fawn or lemon fawn. There have been seventeen volumes of the American Herd Book issued, these containing 12,000 records of bulls and some 22,000 of cows. The Herd Book of the Guernsey Island has been issued to the extent of seventeen volumes, containing 2000 bulls and 10,000 cows. The Secretary of the Guernsey Island Society is Mr. Henry Carre, of Manor Place, Guernsey. No cow can be admitted to the Herd Book without examination at local shows by representatives of the Society, when if the animals qualify they are registered as foundation stock, while their progeny become eligible later on as pedigree stock. There have been twenty-three volumes of the English Guernsey Herd Book, containing the records of 1900 bulls and 7142 cows. It is admitted by members of the English Society that too much attention has been paid to beauty of form and colour, whereas it is now intended with the aid of the "home test register" to ascertain the possibilities of the Guernsey as a utility cow.

The Guernsey breed is one of the hardiest type of milking stock. The butter produced in Guernsey is perhaps the deepest in colour of that from any breed we have. On the Island the cattle are chiefly tethered, especially in summer, their chief food being grass, lucerne, and clover, but great care is taken to keep them in until the sun is shining on the fodder, which means, in other words, that as danger lurks in succulent food it should be consumed when a portion of its moisture has been extracted. In some cases the fodder is mown, and carried to the stalls from twelve to twenty-four hours afterwards. Guernsey stock at the Winter Fat Cattle Show sometimes reaches 1250 lb., not a very high figure indeed, but weighty for milking stock of comparatively small size. Among other foods grown largely in the Island for dairy cows are mangels, carrots, and turnips; but there are some who still decline to use either swedes or parsnips, believing them to be more suitable for butchers' stock. Early in the last century, efforts were made from time to time to induce the Court to admit imported cattle, and on more than one occasion petitions were sent in to obtain consent, with the result that nine parishes combined and forwarded a counter petition, with the result that a law was made forbidding the importation of heifers, cows, or bulls; so that for a considerable period the Guernsey breed has been kept pure, although on several subsequent occasions live stock was imported, but always, as it is claimed, discovered and seized by the officials of the Island.

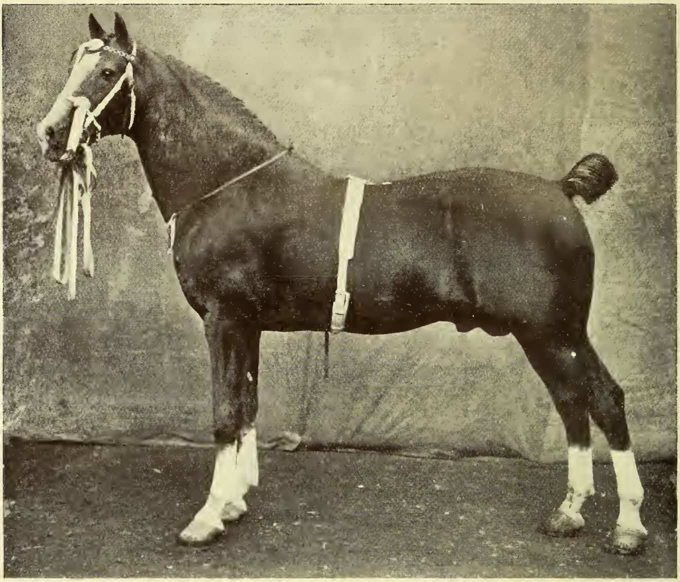
Gypsum.—Few of the cheaper classes of fertilisers have been more widely recommended than gypsum. It may be chemically described as hydrated sulphate of lime, so that it cannot be claimed for it that it possesses any potent fertilising ingredients. Lime and sulphur are both abundant in most soils, and the large percentage of sulphate of lime in all superphosphates enforces its application wherever these two ingredients are required. To apply gypsum in large quantities to land is scarcely advisable, considering the ease with which carbonate of lime can be obtained, and, apart from its constant presence in superphosphates, it is too poor a fertiliser for drilling at the rate of 3 or 4 cwt. per acre.

Gypsum possesses absorbent qualities with regard to ammonia, which renders it very useful in stables. If it is sprinkled behind horses, or in their stalls, it checks the effluvium of ammonia fumes by the simple process of combining with the sulphate of lime and forming sulphate of ammonia and carbonate of lime. It is recommended to adopt the same method in cow-houses, pig-stys, poultry-houses, and other offices. Also to spread it over the surface of dung-heaps to prevent the escape of ammonia. Its use promotes cleanliness and sweetness, and is especially worthy of the attention of horse-keepers, and those who keep live stock in towns and suburbs.

It has been known to produce excellent results when applied to red clover, beans, peas, and leguminous plants generally. In some cases it has also been found effective in checking finger-and-toe in turnips; but this property it shares with lime. The beneficial action of gypsum is of an indirect nature. Its manurial effects cannot be direct, unless in special cases where the simple constituents which compose it are wanting in the soil. They are rather due to double decompositions which gradually take place in the soil, or to special influences in promoting nitrification. It is stated by Aikman that an application of gypsum is equivalent to one of potash, on account of the action of sulphate of lime upon the double silicates of potash in the soil. He, however, remarks that with the increased use of potash salts, the use of gypsum is likely to decline. Warington found that gypsum promotes nitrification by reducing the "alkalinity" of soils to the most favourable degree for the process. The conclusion which cannot be avoided is, that gypsum frequently causes a greater effect than its composition warrants us in expecting, and that ingenious explanations of observed beneficial results become necessary. Certainly, in some cases, its effect upon the growth of red clover has been very striking. Gypsum may be viewed as one of the minor manures. Its merits have been set forward in many pamphlets, and are not denied, although it is scarcely likely that it can successfully compete with the many potent fertilisers now available.

Gypsum is widely distributed, and is known extensively for its fertilising properties. It must be regarded as one of the oldest artificial manures, ranking in this respect with salt. It is largely used in the arts, under the name of Plaster of Paris, Alabaster, Selenite, and Satin Spar. Plaster of Paris is calcined gypsum derived from deposits found largely in the neighbourhood of Montmartre and Argenteuil, near Paris. It possesses wonderful "setting" properties when made into a cream with water, and is very extensively used for cornices, modelling, and many similar purposes.

Gypsum occurs in large quantities in this country, in Derbyshire, and in Nova Scotia, New York, Virginia, and Michigan, etc. It is of dull grey colour when ground, and costs about 30s. per ton.



Babbage.

Hackney Stallion.

Babbage.

Hackney Mare.

Hackneys.—There can be no doubt that the Hackney or some horse of the Hackney type and character has been in great request ever since the country became at all civilised and its inhabitants began to settle in populous centres. A stout horse was necessary for a journey when roads were bad, and as everyone was compelled more or less to take his journeys on horseback, the noble and the squire would endeavour to get hold of a horse that was good-looking, a good mover and easy in his paces, leaving to poorer and less important people the commoner horses. The good-looking horse with action would seem to have been in Shakespeare's mind when he made Edgar complain that the foul fiend had "made him proud of heart, to ride on a bay trotting horse, over four arched bridges," and such a horse as Edgar speaks of may well have been amongst the progenitors of the modern hackney.

Amongst our old writers there is plenty of mention of the stout horse for a journey. The hackney or trotting horse, and our English horses, are highly spoken of by English writers, such as Blundeville, Gervase Markham, and, at a later date, Thomas de Grey and the famous William Cavendish, Duke of Newcastle. These English horses seem to have had many of the attributes of the hackney, but they also seem to have had many characteristics which are certainly not to be found in the hackney with his modern development. This, however, is what might be expected. As time passed on, and the habits of the people became more luxurious, special points such as would ensure large prices from rich customers, would be bred for, and the system of natural selection would soon make of the hackney a very different animal to that "horse of service" which carried his master to the wars and on a journey as well as hunting, a century or more earlier, when roads were rougher and when the surroundings of life were altogether different.

It is interesting to note that Blundeville in a letter to his patron, Robert Dudley, Earl of Leicester, who was Master of the Horse to Queen Elizabeth, is one of the first to mention the hackney as a horse used for pleasure. Blundeville was lamenting the scarcity of good horses in the country, which, it may be remarked, seems to have been a perennial cause of trouble with enthusiastic horse breeders from the early days of the industry, and after referring to the Statutes of Henry VIII. and Edward VI. "touching the breeding of Horses upon Comons," he goes on to speak of the "necessary breeding of Horses for Service; whereof this Realme of all others at this instant hath greatest need," and suggests that the Queen herself should devote all her private parks partly to the breeding of horses. This example, he thinks, would be followed by all noblemen and gentlemen owning suitable parks; and he proceeds to say, "And to the intent that no covetousness might hinder so good an Act: I would wish the covetous mind and desire of all men to be bridled by a law and discipline, whereby it would be provided that not only a sufficient number of able Horses may be bred within this realme, but also that the same Horses may be broken, kept, maintained, and exercised accordingly. Monsieur d'Angeay, in his *Booke of Warre*, would have no man to keep a hacknie or easie Horse to ride on himself, unless he kept also a Horse meete for service in the field."

A curious thing about the writings of Blundeville and his immediate successors is that they all speak highly of the great trotting horse as a "horse for Service," or, as we should call him, a trooper. Blundeville recommends that mares to breed from should "be of an higher stature, strongly made, large and fayre, and have a trotting pace, as the mares of Flanders and some of our own Mares be: for it is not meet for divers

respects that Horses for Service should amble." It is also worth noting that the "Order for Mustering Dymylances and Light Horsemen" in Elizabeth's time insisted on each being mounted "uppon one sufficient stoned trotting hors or else a long trotting gelding."

It is not necessary to follow the old writers any farther at present. The information we are most anxious to have they do not give us. There is plenty of advice as to the choice of stallions, of which there are any number of varieties, such as the Turk, the Jennet, the Spanish horse, etc.; and there are frequent references to mares "strongly made," etc., but there is never any history of those mares, or where they come from, or who bred them, or how they were bred. They are simply our "English" mares; they are taken as a matter of course, and occasionally we are told that they were well adapted for the plough, for the road, and for service, but everything else has to be taken for granted. The Duke of Newcastle, indeed, says of English horses generally, that they "are so compounded of horses of all countries, that they always participate something of their sires," and then he says later on, "For English mares there are none like them in the world to breed on; but then you must chuse them fit for such horses as you would breed."

There must, however, have been an original native foundation before our English mares could have been "so compounded of horses of all countries," and it seems scarcely likely that the native mares would all be of one type. The foundation of the Cleveland bay and the foundation of the hackney must have been originally widely apart in shape and character.

One way, and an easy way, of settling the difficulty is to say that the original foundation on the dam's side was the draught horse of the country improved by an Eastern strain. But we are brought up sharp by the fact that the hackney is a native of two districts—East Anglia and Yorkshire. We may go farther than that, for a couple of centuries ago and probably much farther back there was common in Scotland trotting galloways of great merit, which made a rare foundation for the modern hackney cross. So after all the draught horse of South-East Yorkshire and East Anglia may have been very similar to each other, and have been something of the galloway type with some knee action, on which the Eastern cross would nick admirably.

Whatever may have been the original foundation of the hackney on the dam's side, and however little history may have to tell us about it, there is plenty of information about the male ancestors of the modern hackney, whose history begins but a few years after the history of the great thoroughbred families of Eclipse, Herod, and Matchem.

It is a significant fact in the history of all our light breeds of horses, that not only good thoroughbred blood, but the very best thoroughbred blood of the day, was at the foundation of them, and was for many generations available for the breeders of Cleveland bays, hackneys, and other breeds. This is abundantly shown in many of the pedigrees of the old hackney stallions, more than one of which was only second or third in descent from such horses as Marske and Flying Childers.

Such was the original Shales (699), who flourished in the middle of the eighteenth century, and who may fairly be looked upon as one of the great foundations of the modern hackney. He was by Blaze, a son of Flying Childers, who combined the blood of the Darley Arabian, D'Arcy's Yellow Turk, the Leedes Arabian, the Brownlow Turk, and the Duke of Rutland's Black Barb, an aristocratic pedigree enough. But there was a lot of English blood in Blaze as well as Eastern blood. Unfortunately,

what that English blood was is unknown. His dam was the Confederate filly, whose grandams on both sides are returned in the General Stud Book as having no pedigree. Mr. Euren in the Introduction to the Hackney Stud Book, referring to this large proportion of English blood in the pedigree of Blaze, says that no one can say what was the character of that English blood—whether it was running, trotting, or ambling; but a reference to the Racing Calendar settles that question finally, for Blaze was a fair performer on the turf, winning some nine races out of the fourteen recorded, and an older brother was also a winner, whilst he was the sire of many winners.

The dam of Shales is stated, in the *Norwich Mercury* of 4th April 1772 to have been a hackney mare, and in the Hackney Stud Book that is taken as evidence. John Lawrence says, she was a "strong common bred mare," but as he made a mistake about the name of Shales' sire, it is quite possible that he also made a mistake about his dam. Mr. Euren asks if it is not possible that this mare had superior trotting merits; it is quite possible. It is also probable that she was of the riding type, as her son must have been. Only two of the sons of Shales live in history, namely, Scot Shales, the sire of a great horse in Marshall's Hue and Cry, and a whole lot of horses named Shales; and Driver, a famous horse in his day and sire of a great horse in Jenkinson's Fireaway, who was the sire, amongst other good horses of Wroot's Pretender, from whom a whole host of the best modern hackneys trace their descent. Amongst them Bob Ramsdale's Performer, of whom tradition says that he was the best mover ever seen. That he was a fast horse is proved by the fact that he trotted three miles in nine minutes, and one mile in three minutes with a standing start.

The strong infusion of thoroughbred blood introduced into the hackney in the latter half of the eighteenth century and the early years of the nineteenth, would be remarkable, were it not for the fact that with the improvements in roads a faster horse for the roads was required. It must be remembered that most people took their journeys on horseback, and many Yorkshire farmers thought nothing of riding to Newcastle market and back in a day. It was an age of horsemen, and only the rich indulged in the luxuries of the coach or chaise.

The thoroughbred crosses seem to have been chosen with great skill. It is needless to insist upon the fact that some families of the thoroughbred have much finer trotting action than others, and there are some that snap their knees quite well. The horses used seem to have been mainly of that kind. Prominent amongst these thoroughbred horses was Sampson, a black horse bred by a Mr. Robinson, and once owned by the Marquis of Rockingham. He was in many ways a remarkable horse, and his measurements, which were preserved by John Lawrence, are worth noting. In height he was 15 hands 2 inches; from the hair of his hoof to the middle of the fetlock joint (foreleg) was 4 inches; from the middle of the fetlock joint to the knee was 11 inches, and from the knee to the elbow-joint was 19 inches; he had 8½ inches of bone below the knee, and 9 inches below the hock. Admirers of the horses of the past say that he was the biggest boned thoroughbred that ever existed, which is an assertion which it would not be difficult to prove incorrect. Lawrence thought there was a stain in his pedigree, but he seems to have had no grounds for thinking so beyond the statement of a groom that the dam of Sampson was a hunting mare. How little the memory of grooms is to be relied on there is plenty of evidence. The dam of Sampson may have been

hunted—probably was, but that does not necessarily follow that the pedigree given in the General Stud Book is incorrect, and the writer would prefer to place confidence in the evidence of the Racing Calendar and the Stud Book, which show that Sampson was not only a big winner himself but the sire of winners—facts which are certainly in favour of purity of blood. Sampson was the grandsire of Mambrino, the sire of Messenger, who was practically the foundation of the American trotting horse, and it must not be forgotten that he was half-brother on the sire's side to the original Shales.

Another horse that had doubtless much to do with the improvement of the hackney in the end of the eighteenth century was Jalap, a bay colt by Regulus, for though his name is not often to be found in pedigrees, Marshall speaks of the great good he did in the North and East Ridings of Yorkshire, but says that his sons did not make much name as sires. Trotting Jalap, however, is a name that is found in many old pedigrees, and on the female side the blood of Jalap by Regulus showed its value, as is instanced in the case of that great horse, Ramsdale's Performer (543), whose great grandam was by Trotting Jalap.

Another thoroughbred horse that flourished in the middle of the eighteenth century was Joseph Andrews, a chestnut horse by Roundhead—The Hip mare. He was owned by Mr. Hartley, and was extensively used in the East Riding of Yorkshire, where he made a great mark.

It would occupy too much space to mention even a small proportion of the thoroughbred crosses which were introduced into the hackney breed from 1775 to 1830 or 1840. Hackney breeders of those days seemed to be anxious to introduce a cross of Eastern or thoroughbred blood every few generations, and a careful study of the pedigrees of hackneys which flourished in the period named affords very interesting reading. A few, however, of the older and more famous thoroughbred crosses may be named, and students of Yorkshire coach horse pedigrees will find that the same names will be found at the tap-root of them. Ponteland by Waxy is at the foundation of many great horses which came from the well-known stud of Mr. Francis Cook of Thixendale, and Delpini, Sir Peter Teazle, Highflyer, Borghese, Goliah, and Screveton are names which frequently occur in Hackney and Coach Horse pedigrees, whilst at a later date we have Bay President and President Junior.

During the period just referred to the hackney was frequently found taking a part in trotting matches, the majority of which were against time. Though trotting as a sport never "caught on" in England to any extent, it has no doubt been instrumental in keeping the names of some very high-class hackneys from falling into oblivion, and amongst these must be mentioned the Norfolk Cob and the Norfolk Phenomenon, both of them horses of great merit as performers on the road, and both horses that have left a great mark on the breed.

The Norfolk Cob was bred by Mr. Burgess, and was by Young Fireaway (208), a famous trotter in his day, who strained back to Sampson, Joseph Andrews, and Blank, by the Godolphin Arabian. His dam was by Marshland Shales (435), a horse that had a double cross of the original Shales (699) very near the top of his pedigree through Scot Shales; her dam was without a pedigree. From descriptions of him the Norfolk Cob seems to have been a short-legged horse, about 15 hands high, with good fore-hand and shoulders, and we are told that he was well up to 20 stone. He was sent by Sir William Codrington to the West Indies when he was twenty-four years old, and was probably the oldest horse of any breed that

ever was exported to such a distant country. He was the sire of Kendle's Norfolk Cob (476), Railway (654), whose dam, a half-bred mare by Sir Peter Teazle, trotted a mile in 2 minutes 40 seconds, and of a far greater horse than either of them in the Norfolk Phenomenon.

This horse's dam was said to have been by Read's Fireaway (202), but there seems to have been some doubt on the subject. Whoever his dam was, however, she must have had some good breeding behind her somewhere; the way in which her son's success as a sire stands out is sufficient proof of that. Few horses have had such a long and successful career at the stud. He travelled in East Anglia till he was eleven or twelve years old, covering a wide district in that time, including South Lincolnshire and Horncastle. In 1838, when fourteen years old, he became the property of that fine judge, old Bob Ramsdale of Market Weighton, and then of his son, Philip Ramsdale, who in 1848 took him into Scotland, where he also sired many good horses. He trotted in matches when he was nearly thirty years old, and died at Edinburgh at a good old age. From him are descended a multitude of good horses, and amongst them may be mentioned several of the name of Prickwillow, one of which, Cobbin's Prickwillow, who was a son of his, from a Flamingo (277) mare, was a Royal and Great Yorkshire winner.

It is unnecessary to go into any details respecting the trotting matches to which reference has already been made. When they were most popular, so far as can be gathered from the few records of them which are to hand, a sudden change was brought about in hackney breeding by the rapid introduction of railways. The new departure in travelling soon took the coaches off the road, and hackneys were now no longer necessary for long journeys on horseback. There was to a certain extent—even to a considerable extent—the same kind of slump as took place in the breeding of Cleveland bays and Yorkshire coach horses, but it was not so serious as was the case with those breeds. For this more reasons than one may be given. In the first place, the hackney as he then was, was a saddle horse, and a very good saddle horse too. He was a handsome, nicely balanced horse, a fine mover, and a showy horse either in the saddle or in harness. So there was a market for him, and not a bad market either; and though no doubt many breeders gave up in despair, scared by the railway movement, the Yorkshire and Norfolk farmers, the descendants of the men who may be looked upon as the pioneers of hackney breeding, were not to be discouraged, and they were especially careful to keep the blood which had proved so valuable in the past. Then something of hackney character was needed for those farm and country houses which lay far out of the track of railways, at any rate until the development of branch lines.

Then happily for the hackney, just as railways began to increase, and altered the whole system of English travelling, so did horse shows increase and multiply, and horse shows—at any rate in Yorkshire and Norfolk—without hackney classes were scarcely to be found. So that during the time which elapsed between the establishment of railways and the formation of the Hackney Horse Society, there were inducements for men to breed good hackneys, and though there was no doubt a falling off both in demand and price, it was not so serious as to prevent a goodly supply of hackneys being bred.

During this period there flourished a couple of stallions which made a great mark on the breed, and which, more perhaps than any other, have contributed to the building up of the hackney in his modern development. These horses are Triffit's Fireaway and Bourdass' Denmark. The rivalry

between the pair was very great, both in the show-ring and as sires, but as a show horse at any rate the former may be said to have had the best of it.

Fireaway (249) was foaled in 1859, and was by Achilles 2 (Hairsine's)—Nancy by Performer (Ward's) by Norfolk Phenomenon (522) (V.S.). He was a dark brown in colour, and stood 15 hands 2 inches, which, it may be remarked in passing, was considered about the right height for a hackney in the fifties and sixties. He was full of quality and a remarkably fine mover. He came from a prize-winning strain, for his dam was a Great Yorkshire winner, and amongst the twenty-nine first prizes he won of which a record remains, there was a first at the Royal at Manchester and a first at the Yorkshire at Wetherby, both fine performances.

Amongst the most famous of his sons may be mentioned Bismarck (73); Vary's Fireaway (263), the winner at the Alexandra Park Show in 1874—a fine performance; Foster's Fireaway (288); Landseer (402) (Triffit's); Phenomenon (582) (Brough's); Sir Edwin Landseer (773) (Triffit's); and Sir Garnet (776) (Postill's). As a proof of his impressiveness as a sire it may be said that ten out of the twelve sons of his whose names are given in the first volume or Stud Book were of the same colour as himself. It may be of interest to add that he had two crosses of Norfolk Phenomenon, and one of Ramsdale's Performer, and one of Burgess's Fireaway in his pedigree, and that amongst the thoroughbred crosses of which there were several are Ponteland by Waxy (winner of the Derby) and Borodino by Smolensko (winner of the Two Thousand).

Denmark was a chestnut, standing the same height as Fireaway, and he was three years younger than that horse. He was a stylish horse and a fine mover, and like Fireaway he won his share of prizes. In the show-ring, however, he was not such a conspicuous success as his rival, for he has no Royal or Great Yorkshire prizes amongst the many that are credited to him, his best performance at the Yorkshire Show being a third at Beverley. He was, however, shown with his dam at the Yorkshire Show at York in 1862, when she won in the brood mare class, being then twenty-three years old.

As a sire, Denmark was a conspicuous success, and as a sire of stallions he certainly stands in front of Fireaway. To begin with, there is the most famous of his sons, Danegelt (174), for which horse Sir Walter Gilbey gave 5000 guineas when he was thirteen years old. Other good stallions by him were Dorrington (184); Charley Denmark (130), a winner in good company; Moore's Confidence (163), who beat Danegelt at Manchester in 1883; Fordham (287), who was exported to Canada; Lord Derwent (418), a good prize-winner and an excellent sire; and Moore's Sunbeam (819).

Denmark's pedigree is worthy of careful study. He was by Beal's Sir Charles (768), who had three crosses of Ramsdale's Performer (547), and one of Burgess's Fireaway (208), and whose grandam was third in direct line from Filho da Puta on the sire's side. His dam was by Rickell's Merryman (458), a grandson of Ramsdale's Performer, and Burgess's Fireaway (208) comes into her pedigree twice; and her grandam was by All Fours by the thoroughbred Hyperion. There was some good thoroughbred blood too in Fireaway (208), for his dam was by Skyscraper, a son of the great Highflyer.

The pedigrees of the two great rivals have much in common. They both have crosses of Ramsdale's Performer and Burgess's Fireaway, and they both have a remarkable mixture of high-class thoroughbred blood in them. Which has been the better influence in the production of the modern hackney will always be an arguable point, for if the Denmark

sires have been conspicuous by their successes, the Fireaway mares are at the foundation of the pedigrees of most of the best horses of the day.

Many circumstances combined to bring about a remarkable increase in the foreign trade of good horses in the middle and later seventies. The United States had recovered from the long war, and her enterprising citizens were opening up and developing the marvellous resources of their great country in a way which had not only never been attempted before, but which could not have been anticipated by the most sanguine, and they wanted horses of all breeds to form the nucleus of those studs which have since become famous. The Continent, too, had recovered rapidly from the disastrous Franco-German war, and on the Continent—in Germany, in France, in Russia—English horses came once more into great request. Then again the Franco-German war had brought about a scarcity of a certain and very useful class of horses. Those whose memories take them back thirty-seven years will not need reminding how French and German agents thronged our horse fairs, nor of the prices they gave for useful troop horses. And the Franco-German war had also shown very clearly that even with the great improvement in gunnery, and in mechanical means of locomotion which had taken place since the last great war, cavalry not only maintained its place as one of the most important branches of an army, but that it was one which could not be done without.

So there came a stimulus to horse-breeding such as there had never been since the Railway era commenced. Men began to think that they had, after all, been in too great a hurry to neglect what looked like being a very profitable business, and to regret that they had parted with so many mares, mares that would have made an excellent foundation to breed the class of horses for which there seemed to be a brisk and increasing trade. It was natural that an attempt should be made to meet this demand; inquiries began to be made about mares, and where they were to be found, and old records and old pedigrees were carefully hunted up and studied. At the same time the agricultural and stock papers took up the question of horse-breeding on scientific lines, and the ruling bodies of agricultural shows began to differentiate between the different breeds, and we no longer saw, at a national show, the anomaly of Clydesdale, Shire, and Suffolk Punch horses grouped together under the generic heading of Agricultural Horses.

For some years the way had been gradually preparing for Breed Societies, and the want of them was beginning to be acutely felt before their establishment. In 1883 and 1884, Mr. Henry F. Euren wrote a series of very interesting letters to the *Live Stock Journal* about the hackney, and the immediate result of those letters was the formation of the Hackney Horse Society. The Society was formed in 1883, and was incorporated on 19th January 1884.

The first volume of the Stud Book was published in May of that year, and was an important event in the history of the Hackney—more important, perhaps, than the first publication of a Stud Book generally is. For the Secretary, Mr. Henry F. Euren, had had exceptional opportunities for obtaining information respecting the breed of which he is such an enthusiastic admirer, and it is only right to say that he made use of them in an exceptional way. The files of the *Norwich Mercury*, of which he was then the editor, contained a wealth of information about the favourite horse of East Anglia, but Mr. Euren was not content with that, and the Historical Introduction to the Hackney Stud Book is unique for the light which it throws upon horse-breeding in the past. Within two years of the formation of the Society a London Show was held at the Royal Agricultural Hall, and these

shows have grown into very large and important gatherings, where breeders and customers meet, and where the best horses of the day are to be found in competition.

Very soon in the history of the Society it became evident that the members were not quite at one about what a hackney should be. The old idea of a hackney was that he was a saddle horse, that could also be a good harness horse if wanted, and men who were of this opinion scouted the idea of a hackney being more than 15 hands 2 inches in height. Indeed, at the Royal Show and also at the Yorkshire, the height limit of hackneys was 15 hands 2 inches. When the Stud Book was published it was found that there were fifty horses whose pedigrees were registered in it that stood 16 hands.

Hence at once there was a revolution in the conditions under which hackneys could be shown, and it was one which could not fail to have a marked effect upon the breed, as will be readily understood when it is mentioned that such horses as Powell's Black Shales (84), Cooke's Eclipse (191), West's Fireaway (204), Giddens' Great Gun (323), a horse that made a great name as Sutton's Performer, and other well-bred hackneys had no chance of obtaining the highest honours of the showyard up to this time. And there was another way in which the new state of things affected the breed. It soon became evident that the big upstanding hackney would find a ready market as a fashionable harness horse. For this his elegant forehand and his showy action admirably fitted him, and from the time that hackneys of 16 hands and upwards came to be shown may be dated the modern maxim that the hackney is eminently the harness horse of the day, and that he is no longer to be considered as a saddle horse. There has been, and there is likely to be, a considerable difference of opinion on this score, and though it is outside the scope of the present article to take any part in the controversy, it may be pointed out, without offence to either party, that whereas a good saddle horse with action always makes a good harness horse, the reverse is by no means the case; and, again, that what are euphuistically known as "harness shoulders" are not a strong point in any horse, the term itself being of an apologetic nature.

The Hackney Horse Society was established at a happy moment. It not only took the tide of foreign trade at the flood, but its establishment, if it did not bring about the patronage of the hackney from many enthusiastic gentlemen who were interested in horse-breeding as a subject of national importance, at any rate brought that patronage more in evidence, and the consequence was that the example set by the late Lord Londesborough, Sir Walter Gilbey, Mr. W. A. Burdett Coutts, M.P., Mr. Tom Mitchell, and others too numerous to mention, was eagerly followed, and large and characteristic studs were established all over the United Kingdom. The show system, which was carefully developed, acted as a stimulus to breeding, and when harness classes increased in number all over the country as they very soon did, the popularity of the hackney increased, and the demand for high-stepping harness horses good enough for show purposes became very brisk, and, notwithstanding the introduction of the bicycle and the motor car, which has had at least a temporary effect upon the hackney trade, in this branch of it the demand is as great as ever.

Another good influence which the Hackney Horse Society has had upon the breed is that through it the Yorkshire and Norfolk breeders have come more together and that Norfolk horses have been used in Yorkshire and Yorkshire horses in East Anglia, and with excellent results. This, however, cannot be looked upon as a new departure. Lawrence speaks of Yorkshire

stallions being brought into Norfolk, and he also says that the result of the cross was anything but satisfactory, a statement which must be taken with more than the usual grain of salt. For Lawrence, though undoubtedly an able and painstaking writer, was not altogether clear of prejudice, and he was apt to place considerable reliance on the word of grooms. There is, when speaking of horses, far too great a tendency for all but the most unprejudiced and careful observers to generalise from the particular; and the excellent results which have been derived from recent introductions of Yorkshire blood into East Anglia justify the opinion that Lawrence was indulging in that very dangerous form of reasoning. Then, again, old Yorkshire breeders took good Norfolk horses into the East Riding, of which one instance has been given in Bond's Norfolk Phenomenon.

But since the publication of the Stud Books this change of blood has been much more frequent; and it has moreover been conducted on more scientific lines. Space does not admit of alluding to more than two of the changes of locality; but both of them were of the greatest importance, and produced the best results.

The first of these is Rufus (1343). He was bred by Messrs. Peacock of Hockwold, near Brandon, and was by Vigorous (1215). His dam (No. 200) Lady Kitty was by Jackson's Quicksilver, who was by Performer (Baxter's) (552), and this was the only hackney cross in his pedigree, his dam being a thoroughbred mare by Wentworth. Lady Kitty's dam was by the thoroughbred Tamworth from an Inspected mare. It is worth noting that Lady Kitty's name appears twice and that of Eva, her own sister, once in the pedigree of Vigorous (1215), and that in Rufus's pedigree there is as much thoroughbred as hackney blood. Rufus was purchased by Mr. Henry Moore of Burn Butts, for whom he won the Challenge Cup at the Hackney Horse Society Show in 1890 and 1891. He died shortly afterwards from an attack of inflammation, and his early death was undoubtedly a serious loss to the breed. Amongst his stock may be mentioned Chocolate Junior, Hedon Squire, Cicely and Stella, all of them great prize-winners. The two mares were from a Lord Derby II. mare, and it may be mentioned incidentally that the Lord Derby II. blood on the female side is invaluable, Lord Derby II. mares nicking admirably with most good strains, but especially with Danegelt horses. Lord Derby II., like Rufus, died all too soon. The other importation to which reference has already been made was that of Danegelt to Elsenham. His sire, Denmark's, pedigree has already been noticed. On his dam's side he comes from a famous strain owned by Mr. Rickell of Warter. His dam Nellie by St. Giles (687)—Nellie by Napoleon (465) has a couple of crosses of Ramsdale's Wildfire (864) on the sire's side, and Norfolk Phenomenon (542) comes in through Wilkinson's Shakespeare (698) on the dam's side, as well as Ramsdale's Atlas (330) and Chadd's Black Shales (83). He has been very successful in his new home, and many of his sons have made for themselves a great name in the showyard and at the stud, amongst which may be mentioned Bonny Danegelt and Royal Danegelt.

The modern tendency of hackney breeding seems to be to breed big upstanding harness horses. The bigger the better, if they have quality and action, is the cry of fashion. Whether it is a reasonable or even a wise cry is questionable. The hackney as he was fifty years ago was a handsome horse, nicely balanced and with beautiful quality, and it is certain that there is considerable risk in losing the type in the effort to breed horses of exceptional size and strength. We see this in some modern horses. We find in some of them that the shoulders are not quite so well placed as they

should be; that the back ribs are deficient, and that the back falls far short of the powerful muscular back for which the hackney was distinguished but a short time ago. In the second- and third-raters these defects are accentuated, and upright shoulders and slack on the back would not be an inaccurate description of some.

It must not be thought that there is any intention to convey the idea that the hackney as a breed has deteriorated. Such is by no means the case; but there is a danger in the tendency of the modern demand for size—*i.e.* height, and it is as well to point it out. There was at one time also considerable danger that in the search for more snap of the knee the beauty of true action might be lost sight of. There is no longer any danger in this direction. Men are becoming better judges of action; they look quite as keenly for the how and where a horse puts his foot down as they do for the way in which he picks it up. The somewhat vulgar action that once looked as if it might become the vogue has no chance in the show-ring or in the sale-ring now.

In another respect hackney breeders are taking great care, and that is in breeding to colour. A very few years ago it mattered but little what was the colour of a hackney provided he was fairly well shaped and moved well. Gaudily marked chestnuts were consequently very much in evidence—horses with broad white blazes down their faces and with three or four white legs up to knee and hock were numerous, and indeed in many instances formed the majority of big and important classes. There has always been a dislike to gaudily marked chestnuts for harness horses, and the demand for hackneys as high-class carriage horses no doubt fell off considerably on account of the prevalence of this colour. During the last few years, however, a great improvement has taken place with respect to colour, and though, owing to the number of high-class horses which have been chestnuts, such a thing as breeding that colour out would seem to be impossible, there is no doubt that more improvement can be made in colour as time goes on.

The hackney is distinguished by his fine forehand and well-placed shoulders. His head is well put on and shows quality, and these are important points which should never be sacrificed in the interest of high stepping, however fashionable that may be. Good shoulders especially are essential, and are of as much importance in a harness horse as in a saddle horse. The horse with moderate or badly placed shoulders is never surefooted, and if anything should cause him to trip, he has never that "leg to spare" which saves many a bad accident. A short muscular back and well-sprung ribs are also important points in the hackney. His quarters are shorter and not so level as those of the coach horse, but they should not be "jumped up," and the tail should come well out. The arms and thighs should be muscular and the cannon bone short to stand the wear and tear of the road. An important point in his action is that he should flex his pasterns well, otherwise he will be rough in his paces. That he should get his hind legs well under him is of course a necessity. Notwithstanding the present fashion for height and substance, perhaps the best height a breeder can endeavour to obtain is from 15 hands 3 inches to 16 hands 1 inch. Horses of that size, with quality, action, and colour, will always find a ready market.

Authorities.—Blundeville, *The Four Chiefest Offices of Horsemanship*; Gervase Markham, *Cheape and Good Husbandry for the Well-ordering of all Beasts and Fowles*; Thomas de Grey, *The Compleat Horsman and Expert Farrier*; the Duke of Newcastle, *A New Method and Extra-*

ordinary Method to Dress Horses; Historical Introduction to Volume i. of the Hackney Stud Book, by H. F. Euren; Vinton's Handbooks, "Light Horses"; *The Hackney*, by Vero Shaw; Sir Humphrey de Trafford's *Horses of the British Empire*; *The Hackney*, by Sir Gilbert Greenall.

Hæmoglobinuria, Piroplasmosis, or Red-Water of Cattle.—This condition, whose most striking feature is the red colour of the urine, has a wide distribution over the globe. From time immemorial it has been recognised as a disease of cattle in Cornwall, Devon, the northern counties of England, throughout Scotland, and in many parts of Ireland. Diseases of the same nature, if not absolutely identical, affect cattle in the United States, South Africa, Australia, the Argentine, and other countries. In various parts of Great Britain the malady is known as "red water," "black water," "blood murrain," "dry murrain," "muir ill," "moor ill," etc. Investigation into a disease long known in North America as "Texas fever," or "tick fever," and suspected to be in some way connected with certain skin parasites—cattle ticks—led to the momentous discovery that the parasite, on which this disease depends, is carried from one animal to another by ticks. This discovery has led to many others of even greater moment, and, as a result, many important and formerly obscure diseases are connected with the true causes. It may be taken that the distribution of red-water of cattle coincides to a great extent with that of cattle ticks. It does not, however, follow that in districts where cattle ticks exist, red water shall affect the cattle, for it is not probable that all ticks are infected with the parasites on which the disease depends.

The disease is more commonly observed in animals above two years than in those under that age, though it has been occasionally noticed in calves. Cattle reared in a place given to red-water usually resist the disease, or take it only in a mild form. This may possibly be accounted for by their having been inoculated with small numbers of the parasites in their youth, or at a time when they are not very susceptible, or the immunity may have been to some extent inherited. In adult cattle, purchased and brought on to a farm given to red water, the attack is usually much more severe. It is most often met with in cattle at grass, from May to October, as that includes the period when ticks are most active. It is, of course, possible for the symptoms to come on while an animal, which has been infected at grass, is in doors, but this usually occurs when such an animal has been subjected to some debilitating condition, such as calving. Rough unbroken pastures, moorlands, scrubs, etc., where coarse, dry herbage exists, are the situations in which the disease is usually acquired, as such favour the life of ticks, while cultivated land is far less commonly associated with the disease on account of the condition, those being unfavourable to the existence of ticks.

Symptoms.—In considering the symptoms it is necessary to realise that the affection exhibits an acute or severe type, and also a mild or benign type, and that the manifestations vary widely.

The *acute* form is usually found in purchased animals, which have been bred on a place not liable to red water. The attack comes on suddenly, the patient separates itself from its fellows, is extremely depressed, does not feed, has a dry, staring coat, moves with a staggering gait, breathes very rapidly, often grunting, or grinding the teeth. In milch cows the milk is diminished and occasionally has a pinkish tint. The pulse is small and very frequent, and the heart may "thump" loudly. The membranes of the eye

and mouth are of a sickly, light yellowish colour. The temperature varies considerably, sometimes reaching 106° Fahr. or 107° Fahr., falling 3 or 4 degrees and rising again at comparatively short intervals. There is often diarrhœa, which may be followed by constipation, usually regarded by the layman as a very bad sign. In some parts of the kingdom this condition of the bowels has given rise to the designation "dry murrain," or "fardel bound." The cardinal symptom to the stockowners, however, is the bright red blood colour of the urine. It is in reality the only feature likely to establish in his mind the existence of this special disease, and so it is important to realise that though in the vast majority of cases this coloration of the urine exists and is discernible, occasionally in severely acute and rapidly fatal cases, the redness is not so prominent. If a little blood is drawn and examined with the microscope, the red blood corpuscles are found to be much reduced in number, and the parasite which causes the trouble will be discovered in the corpuscles. This is, of course, a matter for the expert. Such changes as those described are liable to be associated with other symptoms, such as extreme drowsiness (coma) or brain excitement. Cases regarded as acute may last for four or five days before the fatal termination. In a small proportion recovery takes place. The most favourable sign is a return of the urine to the natural colour, with which the other symptoms usually tend to disappear, but the animal remains for a long time in a debilitated state.

The *mild form* is usually observed in young animals bred on a farm liable to red-water. Some slight discoloration of the urine may be noticed, the subject receives a check to putting on condition, looks dry and unthrifty, and is apparently "out of sorts." These symptoms ordinarily pass off in a week or two, though they may return after irregular intervals. The discovery of ticks on the skin has a certain significance, though from what has been said above it cannot be regarded as conclusive.

Regarding the *cause*, many theories have been advanced, none of which it is necessary to discuss here. It has been for a long time recognised that the redness of the urine is due to the addition to it of the red colouring matter of the blood, and as it frequently occurs in situations whose herbage is poor, it was taken for granted that it was the result of poverty of the blood brought about by innutritious diet. It is now known that microscopic animal parasites, named *piroplasms*, attack the red corpuscles of the blood and bring about discharge of their red colouring matter, which is drained off from the blood in the kidneys and so appears in the urine. These parasites (*piroplasms*) are introduced into the blood by cattle ticks, which are specially arranged for piercing the skin and sucking the blood. If a few drops of blood are taken from an animal affected with red-water and inoculated into a healthy animal, the latter takes the disease. It is therefore within the range of possibility that the disease may be produced by introduction of the germs through a wound, etc., without the intervention of the tick, also it may yet be discovered that other skin parasites may introduce this piroplasm. This, probably, could occur but rarely, and for all practical purposes we may take it that it is nearly always introduced into the animal's blood by the cattle tick. There are different species of ticks, and it is not quite settled which species is responsible for spreading the malady under consideration. This knowledge is desirable, but probably not essential. The tick has a peculiar life-history. Part of its existence is spent on the animal of the species of which it is parasitic and from which it probably gains all its food, and the other part on the ground. The adult female is impregnated by the male

on the skin of the animal or elsewhere, she gorges herself with the blood of her host, and drops off on to the ground, where she deposits a large number of eggs, each of which under favourable circumstances hatches out a small six-legged larva. This hatching may occupy days or months, according to the temperature of the atmosphere, etc. The larva now becomes attached to dry grass, etc., and at the first opportunity fixes itself on to the skin of cattle, with whose blood it fills itself. At the same time the larva may introduce the piroplasms into the blood of the cattle, and cause the disease, or it may be that the blood now taken by the larval tick is from an animal containing these parasites. Having had a full meal, the larva falls off and goes through another advance in development and repeats the former process. According to some zoologists this attacking of animals and falling off occurs three times in the life of the tick. This is interesting, but, perhaps from a practical point of view, may not be regarded as of great importance. It will be realised that the cattle tick plays an important part in the keeping up of the disease, and if there were no ticks it would probably cease to exist.

The prevention of red-water would appear to depend on the eradication of ticks, but no means of completely effecting this at once are at our disposal, except by keeping animals whose blood they suck away from places infested with ticks. It is perhaps necessary to state that, as a rule, one species of parasite will live only on or in animals of a particular species, and that without the special host they cannot survive. Cattle ticks are believed to be special to cattle, but this is not proved. There is, however, good reason for thinking that neither horses nor sheep suffer from this form of red-water. It is, therefore, highly probable that if cattle are kept off infested grazing places for a whole year, or, better, for two winters and one summer, the ticks remaining there would be free from the piroplasms and so be harmless. In the meantime, horses and cattle could be grazed there. Under all circumstances newly purchased animals should not be placed in dangerous situations. Cattle may be vaccinated against "red-water," but there is some little risk, and this practice can only be entertained for very dangerous situations.

Efforts should be made to destroy ticks by applying dressings to the skin; almost any effectual sheep dip answers the purpose. Affected animals should be housed for two or three weeks, the manure, etc., burnt, and all other means used for destroying ticks, which would then be full of infected blood. Affected cattle should have an extra supply of food, tonic medicines, and common salt.

Hæmoglobinuria or Black-Water of Horses.—This affection is probably more commonly known as "black-water of horses." Among other names applied to it are "black strangury," "azoturia," and "hæmoglobinæmia," the last being perhaps most technically correct. Animals so affected were sometimes included by the older writers under the designation "kidney droppers."

It is a disease of which very dark-coloured urine is a striking symptom, hence the common name. This discoloration is, however, merely one symptom, the more important manifestation being comparatively sudden loss of power. Always serious, the malady is probably fatal to about 50 per cent. of its subjects. Formerly it was regarded as affecting mares only, and by some authorities believed to be a form of "hysteria," under which name it was described. It is now known to attack horses irrespec-

tive of sex, and to be as common in males as in females. It occurs at all seasons of the year, though possibly a larger number of cases are met with in winter than in summer, because frost more frequently entails long periods of enforced rest in the stable. The disease attacks almost invariably well-fed, hard-working horses, which have rested in the stable—usually tied up in stalls—during which period of rest a working allowance of food has been consumed by them. It is remarkable that "black-water" is rarely, if ever, met with in horses which have been at rest in loose boxes, or those allowed a restricted or rest diet, and we have never met with a case in a horse kept regularly at work. The attack comes on soon after the horses so rested are first taken out of the stable and put to work or exercise; it may be after having gone a hundred yards or a few miles, but rarely beyond an hour after leaving the stable. Cases have been met with in the stable when a horse, taken from hard work and tied up for four or five days in a stall, has been put into a loose-box to "stretch its legs." The period of rest in the stable is usually about four or five days. Ordinarily only a single case occurs at the same time, though, under special circumstances, several animals may be simultaneously attacked. This latter occurrence has been noticed more frequently in farm horses, fed highly on beans and working hard at preparations for tillage, being suddenly thrown off work for a few days by frost or other unfavourable conditions, and during the rest receiving the full nitrogenous diet.

The nature of the affection, or rather the nature of the material causing the discoloration of the urine, is now well known to be the red colouring matter of the blood, which has been dissolved out of the red blood corpuscles. The exact cause of this solution has not yet been determined. However desirable it may be that this should be scientifically explained, it is fortunate that we possess such knowledge of the predisposing cause as will allow of the suggestion of means to prevent the occurrence of the disease. And for practical purposes it is perhaps enough to know that a liberal diet, especially of beans, peas, oats, etc., to horses resting for a few days is very liable to be followed by the appearance of red blood crystals in the urine and the conditions now to be described. In view of the fact just mentioned, *i.e.* that usually only one animal of a considerable number, all treated in the same way, becomes affected, it would appear that the changes may be influenced materially by some special state of the system of the individual horse.

Symptoms.—In the diagnosis of "black-water" the recent history of the horse will be of great importance. The first symptom usually observed is some stiffness of gait or lameness, soon after which the animal comes to a "stand still" and cannot proceed, usually falls down, and is unable to rise. If the animal is pushed after the first symptom named he may fall very suddenly. Attacks vary widely in severity, and some animals may not "go down" until they reach their stable. As a rule, while lying down the animal kicks and struggles violently, often doing itself considerable injury, which probably accounts for very bad bed sores so often met with. The loss of power is more frequently of the hind limbs, but occasionally the fore limbs are affected. It becomes evident that certain muscles are in a state of spasm; they "stand out," are hard and firm to the touch, conveying the impression of being "wooden." The muscles usually so affected are those of the quarter, but almost any voluntary muscle may be involved. Though the disease is probably far advanced, that is to say, changes have taken place on which the symptoms depend long before they are manifest, the temperature is little raised until after

the animal has struggled a good deal. In the early stages perspiration may be noticed on parts of the body. Sometimes urine is voided at the outset, but this is not usual. These symptoms in conjunction with the history before described should call for an examination of the urine, which it may be necessary to withdraw with a catheter. It is found to be of the colour of coffee, often resembling the strongest. If some of the urine is put into a small, narrow, colourless glass bottle and held between the observer and the light, it may be noticed to be of a reddish hue. On microscopic examination, numerous crystals of hæmoglobin or colouring matter of the blood and muscle will be discovered. The specific gravity is a little above normal, and some albumen is usually present. After three or four days the urine loses its dark colour and becomes lighter and cloudy. The amount of urine passed in course of the disease is about normal.

On post-mortem examination the hæmoglobin crystals are found free in the blood and in the tissues. The affected muscles are pale in colour and rather dry. The loss of colour is due to the abstraction of the muscle pigment, which appears to be identical with that of the blood, and helps to colour the urine.

The *treatment* of the disease is much more important from the view of prevention than that of cure. It may be entirely avoided by giving horses, which it may be necessary to rest under the conditions named, a little exercise daily, and restricting the strong diet. If horses have been so highly fed for their hard work, a dose of laxative medicine such as Epsom salts during the rest may be advantageous.

The curative measures are far less hopeful. The first consideration is that of getting the affected horse to a stable, for which purpose some kind of conveyance is usually necessary. This is advisable even in the mildest cases, as any exertion appears to increase the force of the attack. If the horse can be got easily into slings and appears comfortable there, this course should be adopted, but not otherwise. When lying down for a long time bed sores are very liable to be troublesome, and special measures, as a good deep straw bed, turning over pretty frequently daily, the application of suitable ointment to any small wounds, etc., should be adopted. The urine should be drawn off with a catheter, and the skin kept warm with rugs, etc. It is usual to give a dose of purgative medicine and to facilitate its action by enemas. Probably this treatment is indicated in most cases, but the real nature of the cause of the affection is so obscure that satisfactory lines for the administration of drugs cannot be set out as being applicable in all cases. It is essentially a disease calling for the services of the expert, and to be of greatest value these should be invoked as soon as possible after the attack.

Half-bred Sheep.—Although the term half-bred could, strictly speaking, be applied to any first cross between two pure breeds, it has usually—in Scotland and the northern districts of England at all events—when applied to sheep, been reserved, as a title name, for the first cross between the Border-Leicester ram and the Cheviot ewe, and the subsequent progeny of such crosses when mated together. Half-breds are, therefore, of two classes. There is the half-bred got from the crossing of the two breeds just named, and the half-bred got from putting two half-breds together. Opinions differ as to which are the better class of sheep. Those who are in the showing and tup-breeding business stick almost exclusively to the first cross. They maintain that, provided the parents be right, this system of mating gives a sharper headed animal than can usually be got in the second

generation of the cross. They also hold that the white hair on the face is purer, as a rule, than in the half-bred to half-bred type, and the wool usually closer and denser on the body. On the other hand, there are many farmers who breed regularly the half-bred to the half-bred with the best results. The animals may not always be so showy as the first crosses, but they grow to fully as big sizes and fatten off equally as quickly. An advantage in this system of breeding is that it is usually cheaper where the owner already has the half-bred females, a half-bred ram being, as a rule, relatively cheaper to buy than a Border-Leicester ram. Writing on this point some years ago, Mr. Andrew Elliot, Newhall, Galashiels, who is one of the most eminent breeders and judges of half-bred sheep, says:

"In some minds there is a prejudice against the half-bred and half-bred breed, but in every instance where the rams are selected with judgment and care they can be bred in this way for any length of time without deteriorating in size, style, or value. In this part of the country we have many instances of flocks that have been bred in this way for the last twenty-five years, and have not only been successful, but are growing daily more in favour. Although it is usual to have the rams of the first cross, I am quite convinced that it is perfectly practicable to breed them pure half-bred and have even better sheep, if done with the skill of a judge. There might be a prejudice against them for a time, but I feel confident that the result would be a success. As show animals the ewes got by half-bred rams will always beat those of the first cross (that is to say, if they be bred with care and skill), as they show so much greater weight, which is always an advantage if you have quality along with it."

But while there may be this difference of opinion as to the relative merits of the two classes of half-bred sheep, there is none as to the value of the variety as a whole. In the great arable districts of the south-east of Scotland and the north-east of England, half-breds are *par excellence* the sheep breed of the ordinary commercial farmer. In these districts indeed, it would not nowadays be very easy to farm successfully without them. They require more liberal fare than a Cheviot, but given that, they will grow quickly to big sizes and give an excellent return for the food consumed. In addition to that half-bred ewes have a special value for crossing with other classes of sheep. Thus, in late years, they have been extensively crossed with Oxford and Suffolk Down rams for the production of fat lambs. Lambs of this cross grow to big sizes very early, and it is probably not very wide of the mark to say that Down half-bred lambs now constitute a majority of the early lambs bred in Scotland. Hoggs of this class also do very well when carried forward to that stage, and are highly popular in the feeding districts for "turniping" purposes. Half-bred ewes are also pretty extensively used for the production of what is called three-part-breds—that is sheep bred from half-bred ewes by the use of a Border-Leicester tup. This was a very popular animal in East Lothian and other large turnip-growing districts before the Down crossing became so fashionable, and it is still bred in preference to all others by many farmers, especially where the animals are intended to be fed off as lambs or in the hogget stage.

Although essentially a Border breed, half-breds have spread all over the country in recent years, and now some of the very best of them are to be found as far north as Caithness and Sutherlandshire. Indeed, Caithness and Sutherlandshire half-breds are a feature of the Edinburgh and other markets in the back-end of the year. They grow to fully bigger sizes than the Border half-breds, and the ewe lambs are thus in special demand for breeding purposes, frequently fetching up to 42s. and 46s. per head in the case of

Reid.

HALF-BRED RAM.

Reid.

HALF-BRED EWE.

specially choice lots. The great pioneers of the half-bred breed — for although they have no flock-book they have been recognised for years at the shows of the Highland and Agricultural Society and elsewhere as a distinct breed—are believed to have been Mr. John Borthwick of West Newton, his son Mr. Charles Borthwick, also of West Newton and Mindrum, and the late Mr. Elliot of Lamberton. Each of these gentlemen are known to have bred half-breds from the Border-Leicester ram and the Cheviot ewe many years ago, Mr. John Borthwick having a regular flock very early in, if not before, the opening of the Victorian era. When once the system of crossing Cheviots with the Border-Leicester in this way became known it spread very rapidly all over the Border districts, as it was found that the lambs bred in this way grew bigger and could be brought to maturity much more quickly than Cheviot lambs, while their mutton was of exceptionally fine quality. Another point that told greatly in their favour in those days was that the sheep of the Leicester-Cheviot cross carried a heavier fleece than the Cheviot, and its wool was as valuable per pound as that of the Cheviot, while it was much more valuable than that of the Border-Leicester.

At the time referred to it was the invariable custom of breeders to have both the ewe and wedder lambs of the Leicester-Cheviot cross sold for fattening purposes to feeders, who disposed of them in the fat markets after the animals had been once clipped. Before long, however, flock-masters discovered that the Leicester-Cheviots were admirably suited for the uplands intermediate between the low grounds occupied by the Border-Leicesters and the higher grounds stocked with Cheviots. The result was that some of the Leicester-Cheviot ewe lambs were retained in a tentative way for breeding purposes, and were mated with Border-Leicester rams to produce what has already been referred to as three-part-bred lambs. The Leicester-Cheviot ewes proved so remarkably prolific and such excellent nurses that this system very rapidly spread over all the south of Scotland and the north of England, more especially as the three-part-bred lambs produced from the half-bred ewes became very popular alike with butchers and feeders. The lambs laid on flesh even more rapidly than the half-breds, and though their mutton was rather heavily loaded with fat, the public were not then so fastidious in their taste for lean mutton as they are now. This rapid extension of the system of using Leicester-Cheviot ewes for the breeding of three-part-bred lambs caused a great demand for half-bred ewe lambs and materially increased the average value of draft Cheviot ewes, because a crop of half-bred lambs could be taken from them after they left the hills.

About that time, also, the high prices for grain led to a great extent of comparatively high-lying pasture land being broken up in Gala Water and other districts, and this increase in the area of arable land in the higher districts gave a great impetus to the breeding of half-bred sheep, and still further increased the demand for half-bred ewe lambs, so much so that they realised much higher prices than half-bred wethers of similar age. In time this demand for half-bred ewes and half-bred ewe lambs was accentuated by the fact that on many of the lower and well-sheltered farms, the Cheviot stocks had been displaced by half-bred ewes carrying three-part-bred lambs. This led to the adoption, some sixty years ago or so, of the system of mating half-bred rams with half-bred ewes in order to enable breeders to retain their best ewe lambs for breeding purposes instead of having to buy Cheviot ewes or ewe lambs at the high prices then current. This system spread very quickly, particularly in Northumberland, and was found to be quite satisfactory. Half-breds bred in this way grow as

stated to heavier weights than the half-breds of the first cross, while their mutton is not so fat as a rule as in either the case of the first cross or the three-part-bred. At the same time they have to be very carefully bred, or otherwise there is risk of loss of type and that well-bred-like quality which always counts for so much in any class of stock. The system of breeding half-breds from Cheviot ewes with Border-Leicester rams spread north a good many years ago, and it has remained an important enterprise in many districts ever since. .

The points of the half-bred are just what might be expected from the union of two so closely marked white-faced breeds as the Border-Leicester and the Cheviot. The head should be well covered with pure white hair; the ears should be erect and mobile with a slight inclination forward, and also well covered with white hair; the eye should be bold, bright, and prominent; the forehead should be wide and open; the muzzle should be black like a Border-Leicester, and fairly wide with good open nostrils; the neck should be strong and well set on the shoulder; the chest should be wide and the ribs well arched—it is a great point in favour of a sheep to be thick through the heart. The back should be straight and well carried out to the rump, with quarters wide and long. The wool should incline more to the Cheviot than the Border-Leicester in closeness, and should be very fine in staple and equal all over the body. Finally, the animal should be well planted on fine flat-boned legs, should carry his head well, and be a good walker. This latter is a point of great importance with many judges, and by almost none would a bad walker be placed in the prize-list. But as a matter of fact, when the other points are right, the animal is not usually a bad walker.

Since crossing with Down rams for fat lambs became so general, half-breds have got a further fillip in popular favour, and may now be said to be used in one form or other from one end of Scotland to the other, while in Northumberland they are the prevailing sheep breed. Many are also bought every year to go south into the English counties for crossing purposes. In the higher parts of Berwickshire and East Lothian particularly, many formerly Cheviot farms are now devoted wholly to the production of half-breds for selling to low-land farmers. In these parts of the country it is claimed that the half-bred nowadays pays more rent than any other class of sheep. Some years ago on account of the somewhat confusing nature of the name of the breed, especially to strangers, a proposal was made to have the name changed to "Upland Leicesters." The proposal, however, did not meet with general favour, and was shortly afterwards abandoned. It has since been suggested that "Leicester-Cheviots" or "Cheviot-Leicesters" might be adopted, but so far there has been no very marked response to this either, the breed being simply shown and referred to as half-breds.

The great sale centre of the breed for ewes and lambs is St. Boswells, in Roxburghshire, although many first-class half-breds are now also sold at such centres as Perth, Inverness, Lockerbie, Rothbury, and Alnwick. At St. Boswells centre in the autumn, it is not uncommon for as many as 20,000 head of ewes to be sold in one day to buyers from the Tay on one side to the Humber on the other. These ewes are mainly bought to produce a crop of lambs that can be sold fat along with their dams before midsummer, the ewes being mated, as a rule, with a tup of one or other of the Down breeds. A good many of the ewes are still also bought to produce a three-part-bred lamb, for although lambs of this cross are not now greatly appreciated for "hogging" purposes, the same objection does

not hold against them as fat lambs. Rams of the breed are usually sold at the Kelso Ram Sales in September; also at Lockerbie, Edinburgh, Inverness, Rothbury, and other places.

Being essentially a commercial sheep, the half-bred is not much favoured with aristocratic patronage. He usually, however, makes a fair price when good, rams of the breed in recent years having frequently sold up to £40 and £45, with an occasional one up to £50. Two years ago, although the highest price did not exceed £33, Mr. Jeffrey, Deuchrie, East Lothian, had the fine average of £19, 13s. for ten; twenty from the same exposer last year (1907) averaged £15, 19s., fourteen from Sunnyside (Mr. Mark) averaging £14, 6s. In the showyard the half-bred is best seen at the annual shows of the Highland and Agricultural Society, although again good numbers are usually also exhibited at the Border Union at Kelso, at Edinburgh, and at various other district shows. The well-bred half-bred is a big substantial animal, very growthy-like in appearance, and usually very well covered with wool. At the present time washed half-bred wool is worth almost 1s. per lb., just about as much as can be got for even the best class of Cheviot wool. Like most crosses, half-breds are exceedingly popular with butchers. They not only yield a good percentage of mutton to weight, but the mutton is usually very nicely mixed and attractive to the eye. In recent years half-breds, like most other native breeds, have been a good deal shown at the leading fat stock shows. In 1907 a pen of three wedders shown at the Scottish National Fat Stock, Edinburgh, scaled alive 865 lb.—fully 288 lb. each—and a pen of ewes 708 lb. Cheviots at the same time scaled to 732 lb. in the case of wedders, and to 658 lb. in the case of ewes; these weights, however, being rather exceptional in the case of this breed.

The management of a half-bred flock does not differ greatly from that of most other kinds of low-ground sheep. If they are to be well done to, they must be liberally fed, and in the spring, when the lambs are arriving, or have arrived, they must have a fair run of young grass. While a half-bred ewe is a good nurse as a rule, she must not be stinted in the matter of food, and especially young grass. The general allowance at this time is two to three ewes and their lambs to the acre. Later in the year they will do quite well on old grass, when the stocking can be somewhat heavier. But they are essentially low-ground sheep, and rarely do much good when sent too high to the hill. In winter, ewes coming on to the lambing should get a few turnips or other food on the grass. When they are well done to, half-bred ewes will frequently average two lambs per head over a fair-sized flock, and an average of $1\frac{1}{2}$ lamb is quite common. Ewe lambs, and indeed all lambs, are usually sold in August, ewe ones for breeding purposes frequently fetching up to a couple of sovereigns and sometimes more per head. Wedder lambs are usually a good few shillings less, unless in the case of some special top lots. The clip of a half-bred ewe flock will usually average from $5\frac{3}{4}$ to 6 lb. of wool per animal, hoggs, of course, clipping a little more.

Hampshire Down Sheep.—This important breed of sheep is, properly speaking, an "improved" race of Hampshire Downs, resulting originally from crossing, but for many years past from continuous selection from the most approved types of its own breed. It is now an established class, first recognised as such by the Royal Agricultural Society at its Salisbury meeting in 1857. It is evident that this

recognition must have been pressed upon the attention of our leading society some time after the breed had emerged from obscurity in the counties of Wilts and Hants. It is certain that the breed was well known previously to 1857, and that improvement must have been in progress for many years before that date. If we go back to 1837, we find no mention of a distinct breed answering to the modern type, but evidence of the effect of Southdown crosses upon certain established county breeds. The two races which must be considered as the maternal ancestors of the modern Hampshire were the old Wiltshire "crook" and the Berkshire "knot," both of which have ceased to exist as pure breeds. The former of them was a whitefaced horned breed of large size, and of early maturity. It was said to be the largest fine-woolled race of sheep in England, and carried horns which turned back behind the ears and bent over the cheeks—hence the name of "crooks." The Berkshire "knot" was generally horned, but some were polled. They were strong, active, and tall, and "folded" well; and, when fattened, grew to an enormous size, but generally "took a long time to make fat" (Youatt, 1837). This breed was at an early period crossed with the Wiltshires. The introduction of Southdown rams effected a complete revolution in the character of these two breeds of sheep, but Mr. E. P. Squarey states that from 1815 to 1835 the Downs of North Hants (adjacent to Berks) and South Wilts (bordering on Hants) were very different, the latter being larger and not so uniform in colour as the former, "so that a ewe with speckled face and ears was not always drafted." That there was a strain of Cotswold blood introduced during the same period is indicated in an address delivered by Mr. John Twynam, who was well known in connection with the genesis of the Oxfordshire breed. He is reported to have said (*circa* 1850): "You must have observed an immense improvement in the character of the Hampshire sheep generally within the last fifteen years. I have had my attention called to this fact frequently since I ceased to be a breeder. Can we recognise none of the Cotswold fleece or his more symmetrical proportions? And, when I tell you that in the years 1835 and 1836, and in subsequent years, I sold very many half-bred lambs, and not into Hampshire Down flocks generally, but into those of six or eight of our best ram-breeders, whose names are to be seen at this day upon my books. . . . I trust I may without presumption lay claim to having supplied a portion of the material from which our flockmasters have worked up a better and more valuable fabric." In and for some years after 1840, Hampshires were known as West-country Downs, and differed from Southdowns in their larger size, looser fleeces, and coarser heads. The modern type of Hampshire Down was brought into prominence as a breed by Mr. Humphrey of Oak Ash, near Wantage, Berks. The following extract from a communication made by him to Mr. W. C. Spooner in 1859 indicates that he was by no means the first known promoter of the breed. It runs as follows:—"About twenty-nine years since, in forming my flock I purchased the best Hampshires or West-country Down ewes I could meet with. Some of them I obtained from the late Mr. G. Budd, Mr. William Pain, Mr. Digweed, and other eminent breeders." It was the great improvement effected upon the Cotswold breed by crossing with Leicester rams that induced Mr. Humphrey to purchase Southdown rams from Mr. Jonas Webb of Babraham, Cambridgeshire, with a similar object in view as regarded his Hampshire flock, and his first venture was made in 1842. The writer of this article was well acquainted with Abraham Hopkins, who was

shepherd for Mr. Humphrey from 1842 to 1868, and he said that "when Mr. Webb's sheep came, master would stand and look at them for two or three hours; or when a good lamb fell from a favourite ewe, he would stand and look at it, and move it about, for an hour or more." When questioned as to whether he meant hours literally, he replied, "Yes, sir, and more; he would tie up his horse outside the pen, and look at the sheep for hours." He had three rams from Babraham for which he paid 60 guineas each at intervals of about two years, and these were all the rams he ever bought from Mr. Jonas Webb or any one else, and he only bought ewes once, and that was a lot of a hundred, of which he kept twenty-five, and sold twenty-five to Mr. Rawlence of Bulbridge, and fifty to a neighbour. Besides these ewes no others were bought, except it might be one or two which struck him as desirable. Fresh blood was used with great caution and introduced gradually — that is, an imported ram was given a few ewes, and his ewe lambs were saved as dams of future rams. When Mr. Humphrey died in 1868 his flock was sold, and among the buyers were Messrs. Rawlence, Canning, Parker, Budd, King, Ferris, and Child. Mr. Rawlence and Mr. E. Waters were usually buyers at the annual ram sales. Among these earlier breeders Mr. James Rawlence of Bulbridge deserves special notice. He began with Southdowns, but proceeded by gradually drafting all small and delicate ewes, and crossing with Hampshire Down rams. He was a purchaser of Hampshire Down ewes, and by fresh infusions of the best blood, and rigorous selection, brought his flock to a high state of perfection, so that by many he is regarded as the father of the breed. Mr. Spooner in 1859 wrote of Mr. Humphrey's flock as distinct from any others, and applies to them the expression *sui generis*, from which we may infer that one more step was necessary before the Hampshire Down could be regarded as a uniform and homogeneous race. In the accomplishment of this object Mr. Rawlence took a leading part, and we may look upon the Bulbridge flock as having at the time of its dispersion fairly represented the Hampshire Down as we see him at the present time. Its sale redistributed some of the oldest blood, and refreshed a large number of established flocks of similar character. The improvement above described was perpetuated through the efforts of Messrs. Dale, Budd, Digweed, Rowden, Pain, and others in Hampshire, and of Messrs. Dear, Cusse, Blake, Smith, Canning, and Waters in Wiltshire. The Bishopton flock was established early in the last century by Mr. W. Rowden, from whom it passed to Mr. Shittler, and later to Mr. E. Dibbin, the father of the present owner. The Chilmark flock was established about sixty years since, and was replenished by ewes purchased from W. Linn, J. King, W. B. Canning, and later breeders.

Mr. Carey Coles' (Winterbourne) flock was derived from that of Mr. J. N. Coles, established in 1850, and therefore had a common origin with the flock of the late Mr. Robert Coles of the Grange, Warminster. The connection between the flocks of the past and the present is therefore established beyond doubt, and the many well-known breeders of our own day confine their purchases rigidly to a few well-known annual ram sales, or to the dispersals of the oldest and best blood.

The Hampshire breed in its purest form is therefore closely related within certain wide limits, and has attained a wonderful uniformity of type. The size of the flocks forbids the idea of too close interbreeding, as most of the accredited ram breeders maintain from 700 to 1000 ewes. The *Hampshire Down Flock-book* was established in 1890 under the editorship of Mr. James Edward Rawlence, 49 Canal, Salisbury, son of the

late Mr. James Rawlence of Bulbridge, and the most recent volume records the breeding of over 400 flocks and of at least 150,000 ewes, besides ewe tegs and rams. The breed prevails over Wilts, Hants, Berks, and the contiguous counties, and encroaches on the domains of the Southdowns of Surrey and Sussex, of the Cotswolds of Gloucestershire and Oxfordshire, and of the horned sheep of Dorsetshire. They are to be met with at the great sheep fairs of Overton, Weyhill, Britford, Wilton, Ilsley, Salisbury, in all of which they constitute the leading feature.

The writer of the present article, as an old breeder of Hampshire Down sheep, and the winner of many first, and some champion, prizes at the Royal, Royal Counties, and other great shows, is qualified to enumerate the points and characteristics of the breed, without diffidence, and at first hand. The *head* should be bold and of black or very dark brown colour—the "colour of a bat's wing"—and covered with white wool, between the ears, over the forehead, and well forward on the cheeks. These characters, which have been expressed as "well coloured and well covered," are pleasing to the eye, and give a sense of uniformity to the flock. The *ears* fall outwards, and are rather long, and black, or of the same tint as the face and shanks. The *eye* is golden coloured and bright. The *jaws* are clean and free from "throatiness," or any development of folds of skin underneath, such as is seen in many Shropshire sheep. The *scrag*, immediately behind the ears, must be wide, and the *neck* muscular and well developed. The *shoulder-tops* must be wide without being coarse, and the shoulders must be well laid back into the "crops." The *girth* is great, and exhibits no slackness behind the shoulders. The thickness from blade to blade, or through the heart, should be great. The *breast* must be deep, wide, and prominent, giving squareness and massiveness to the fore-end of the animal. The *ribs* should be well sprung, and the *back* well covered with firm flesh. The *loins* are wide, and the carcass well carried out to the *tail*, which must be set on in line with the back. The *legs* must be well fleshed outside and inside, so as to confer width and massiveness to the hind-quarters; and the *twist*, or junction of the thighs, must be low, giving squareness to the back view. The *shanks* should be set on well outside of the carcass, so to speak, *i.e.* they must not be too close together, but cover the maximum amount of space. The *pasterns* should be well set up, and the *action* in moving should be sprightly and graceful. The *fleece* should be well closed, and firm to the eye and the touch. It should be entirely free from black spots in every part of the body past the ears, but it is difficult to secure absolute whiteness round the incipient horn spaces. The *wool* should be of fine quality and crisp to the shears. The *skin* should be pink, and the pelt springy and clean. The carriage should be bold and erect, and the mobile black ears and faces contrast well with the white wool adorning the foreheads.

The ram lambs are repeatedly trimmed through the summer, and a finishing touch is added even on the morning of the sale or of exhibition. The bringing out of ram lambs in the pink of condition as regards flesh, colour, and fleece, amounts to a fine art, but is well understood by competent shepherds.

The universal practice of using lambs as sires is peculiar to Hampshire Down breeders, and is probably a cause as well as a result of early maturity. No breed excels the Hampshire in this respect, as may easily be seen by inspecting the exhibits at Salisbury Prize Sheep Fair on 15th July. At this early period there are plenty of lambs on view and for sale, born within the year, weighing 20 lb. per quarter. The writer possesses

records of lambs which weighed as much as 160 lb. live weight at this date, which must have involved an increase of nearly 1 lb. per day from the date of birth. The ram sales and lettings begin towards the end of July and take place mostly in August, and the competition for the best specimens often forces the price up to 80 and 100 guineas for one month's hire. In rare cases 150 guineas is reached, and it must be remembered that this is for lambs, and not shearlings. The averages obtained over the first 100 lambs ranges from 10 to 20 guineas each in the best flock, but excellent animals may be always obtained for 4 and 5 guineas after the "fancy" is satisfied. There is a considerable export trade to Argentina, America, Germany, France, and other countries, but in this respect the Hampshire breed cannot compete with the Lincolns. As to the prevalence of the breed beyond its own counties, there are good flocks in Herts, Oxon, Bucks, Berks, Cambridge, Gloucestershire, Devon, Somerset, Dorset, Essex, Kent, Northampton, Yorkshire, Northumberland, Bedford, Warwickshire, Shropshire, etc. There are also breeders in Ireland.

Among the most noted ram breeders may be mentioned—Mr. James Flower of Chilmark, Salisbury; Mr. Carey Coles, Winterbourne, Stoke, Salisbury; Mr. I. H. Dibbin of Bishopstone, Salisbury; Mr. G. F. T. Drake, Dogdian, Salisbury; Sir George Judd, Cocum, Hants; Mr. Richard Ovey, Badgemore, Oxon; Lord Rothschild, Tring Park, Herts; Mr. H. C. Stephens, Cholderton Lodge, Salisbury, etc.

Flocks and their Management.

Ram-breeding is a special business requiring an extensive area of suitable land, and is successfully carried on upon the chalk hills of Wilts and Hants, where the average natural fertility is low. The fact that the breed thrives upon the "Plain" is a proof of its hardihood and thriftiness, and many of the best flocks are maintained on land rented at a very few shillings per acre. Ram-breeding flocks seldom comprise less than 500, and often over 1000 ewes, and the general management on the farms devoted to them is in a great measure subservient to the flock. The management differs from ordinary usage principally in the great pains taken to improve the flock; liberality in feeding; cropping the land expressly for the perfect development of the ram lambs, and the extreme care taken in training for exhibition and sale. Sheep-farming probably attains its highest degree of perfection upon the first-class ram-breeding establishments situated in Wiltshire and the surrounding counties, where Hampshire Downs are brought out in full perfection in July. A few days' postponement of the day of sale may destroy the bloom and rob the features of their perfection of colour. If, in the desire to obtain extra size and weight, lambing is timed to begin at Christmas instead of in January, the penalty is paid in rustiness of feature and a coarser quality of fleece. Such lambs may triumph at May shows, but are out of the running in July, when younger rivals displace them. There is consequently little inducement to turn out rams before the 12th of August, but at and after that date it is desirable that all the ewes should take season as soon as possible, so as to secure the bulk of the fall in January. This involves a full team of rams, and a judicious management of the flock.

Ewes must be in good condition at the time of mating, and are then drafted on to poorer keep. In ram-breeding the flock is subdivided into a number of groups apportioned to different rams, and it is here that the skill of the breeder is shown in a high degree. Although

to the outsider the differences may be imperceptible, they are glaring to the discriminating eye of the shepherd or of the accomplished sheepmaster. It is indeed marvellous to the uninitiated that the shepherd should know each individual by sight, and be able to pick her out of a flock of a thousand ewes, but such is the case. Equally surprising is it to hear him discourse upon the merits of each member of his flock, and to listen to his remarks upon such apparent trivialities as the colour of the eyes, the set of the ears, or carriage and deportment. The selection of rams is made with the greatest care, and is confined to the purest blood, and the most coveted animals—hence the conflict around the ring, and the high prices given for the best, in comparison with those given for the second best. The ordinary breeder follows upon similar lines, but at a distance, and may be content with a prize for the best 100 wether lambs, or even with satisfactory prices for his annual draft of ewes and their progeny. In any case the entire rural life of these counties is permeated with a keen interest in sheep.

We shall next, and as briefly as possible, describe the management of Hampshire sheep throughout the year, and in doing so glance at the differences in treatment between high-class and medium-class flocks. The districts devoted to Hampshires are not adapted for fattening, and the wether lambs are sold in enormous numbers into the eastern counties and midlands for winter grazing, or directly to butchers at eight months old.

The flocks are maintained in five ages—(1) Full-mouthed (draft ewes), (2) six-teeth, (3) four-teeth, (4) two-teeth (shearlings), (5) ewe lambs. In all but ram-breeding flocks, the full-mouthed ewes are sold in August or September after rearing their lambs, and the six-teeth ewes take their place. In ram-breeding flocks this rule is interfered with to a certain degree by retaining valuable ewes, sometimes for several years after they are full-mouthed. This section is the "usual draft, sound on tooth and bag."

The annual history of a flock commences with the sale of the draft ewes and the addition of the shearling section, which, it may be observed, are generally allowed more indulgence in the form of keep than the older ewes. Rams are usually turned out in August or September, and during the rutting season the flock is kept well and allowed a tie of early turnips in addition to grazing. They are run on stubbles, old seeds, parks, or on the open downs, and are sometimes allowed a little cake. As they are seasoned they are drafted on to poorer keep, so that up to lambing time they live at no appreciable cost. During pregnancy they are allowed an outrun on natural grass, and are folded at night on roots or mustard, and as the season advances they receive a daily allowance of hay. The main fall of lambs in high-class flocks usually occurs about 20th January, and lambing lasts about six weeks. It takes place in close proximity to the lambing-pen, into which the ewes and their newly dropped lambs are removed. The pen is a temporary but comfortable enclosure, fenced in with a double row of hurdles, stuffed between with straw. It is subdivided into yards, which are kept well littered and provided with a large number of "coops" made with hurdles, and covered with a line of thatched hurdles resting on the outer fence, and upon 6-feet piles driven into the ground about 2 feet inside the external wall. These hurdles therefore rest at an angle, first upon the outer circumference of the entire enclosure, and again upon a rail which is nailed along the line of 6-feet piles. These coops are about 6 feet wide, and are completed by a hurdle in front, so that the ewes and their progeny are comfortably housed, and especially protected from the north and east winds. After about three days they are transferred to

Parsons.

Hampshire Down Ram.

Parsons.

Hampshire Down Ewe Lambs.

one of the yards which form the area of the whole pen, and are severally devoted to twins, single ram-lambs, single ewe-lambs, and mixed young lambs. Another yard may be used for ewes about to lamb. The pen therefore consists of several yards, and a ring of coops occupied with freshly lambed ewes. It is further protected by hay and straw ricks, arranged on the north side, which serve as food and for litter. The shepherds are in attendance night and day, and are provided with a house on wheels furnished with a couch and stove, and containing various appliances required during lambing. These pens are the scene of great activity, as they are soon alive with hundreds of young lambs. After the first few days, exit is allowed to both lambs and rams into a neighbouring fold of turnips. The site of the pen is always fixed in close proximity to suitable keep, and hay, straw, mangel-wurzel, and a good water supply are all contrived to be within easy reach of the shepherd. When the lambs become too thick on the ground, the older ones are drafted to more distant fields, where shelters of a temporary character are provided for their comfort.

In following the career of a large lot of lambs, the first step has now been reached. The ewes go on to turnips, but "creeps" are provided so that the lambs can run forward and crop the turnip greens, and enjoy the privilege of separate cribs for hay, and small lamb-troughs for finely ground cake, split peas or other forms of corn. Twins and ram lambs, whether intended for castration or for breeding, are better "done" than the Chilver lambs, and the amount of artificial food allowed varies with the objects aimed at by the owner. The first spring food is winter rye, which is often ready for stocking in February. It is a common practice to heap swedes at intervals over the expanse of green keep, and to throw them about for the ewes. As the season advances winter-barley takes the place of rye, and later (that is early in May) trifolium forms the fold, and mangel is distributed among the green herbage for both ewes and lambs. Trifolium is followed with vetches, and vetches with early sown rape, which brings us to June and July and an exuberance of summer food. During the entire season the lambs are given daily changes, but as spring advances they are shifted during each day into different descriptions of keep. Thus, for example, ewes and lambs on rye and roots are driven daily onto water-meadows from eleven to three o'clock; for these meadows are safe for sheep in the spring of the year. Later they oscillate between trifolium and grass, or vetches and early rape, with a further change in the form of mangel-wurzel. In July these changes of food arrive at their full maximum, and are often elaborate in character. If we take the case either of ram lambs, or wethers meant to realise over 50s. each in August, the life of a lamb is somewhat enviable. At five o'clock on a summer morning the sound of the grinding of mangel-wurzel may be heard in the fold, for, after a feed of ground cake and griddled beans, the lambs relish the cool and watery roots. They are then allowed access to a fresh fold of vetches, and later in the morning they are transferred to a fold of rape, where they eat and rest until the afternoon. They are next allowed to spread over clover-heads or aftermath, and towards evening return to rest on a fresh fold of vetches. Cabbage and early-sown white turnips are ready for them towards the end of July, and thus a series of suitable foods of varied character is provided from lambing time to the final day of sale. Weaning takes place in May, and, after the separation between lambs and dams, the ewes follow their more fortunate offspring, and act as cleaners up. There is no waste of food, for although the sale lambs or ram lambs have the "first chance," the ewe lambs follow, and the stock ewes are always ready

to eat up the crusts and make a clean fold. The ewe tegs are generally folded on swedes and hay during winter, and have their share of green food through the summer, until they join the flock as two-teeth ewes in the autumn.

Next, as to artificial food. Ewes seldom require assistance in this form, unless hay is included in the list. Under this somewhat indefinite expression of "artificial" may be included cake, beans, peas, malt, and other purchased foods, which form a heavy item of expense to those who aspire to ram-breeding. The consumption in large breeding establishments is very great, sometimes in the height of the season amounting to a ton a day. In other cases a more natural system of feeding is adopted, and caking is only resorted to in the case of some sections of a flock. Ram breeders cake the ram lambs and their dams from birth, the twin lambs and their dams, and only omit the single ewe lambs.

As to the quantities given, we may assume that a big Hampshire Down ewe with a lamb or lambs at foot will not think much of 1 lb. of cake per day, and this may be regarded as a representative quantity. During the first days of a lamb's life it subsists entirely on milk, and nourishment must therefore be conveyed to it through its dam. As time goes on the lamb receives small quantities of finely ground linseed cake, split peas, etc., and it is not necessary to increase the total allowance, but the amount given to the ewes may be diminished, while that given to the lambs is increased —still maintaining the quantity at 1 lb. for the two. By weaning time the artificial food may be discontinued to the ewes, and all bestowed upon the lambs. For this reason the daily consumption of cake to the flock need not increase up to weaning.

As crushed linseed-cake weighs about 40 lb. per bushel, it is easy to see that 1 bushel per 100 is a very moderate allowance. Two bushels per 100 is about ·8 lb. per head, and 4 bushels, or a sack to the 100, is a liberal allowance for ewes with ram lambs. After weaning, ram lambs will do well on 3 bushels to the 100, but as training advances this may be increased to 4 or even 5 bushels, which is as far as the writer has known heavy caking to proceed, even on the eve of sale or exhibition. This is equal to 2 lb. per head. The most approved mixtures of dry food are composed of the best quality of linseed-cake and old English beans, quartered; and in many cases a little malt or spiced food is added or given separately. The lambs are fed early and late, and, taking into account the various natural and artificial foods supplied, the dietary will consist of mangel, vetches, rape or cabbage, clover-heads, linseed-cake, beans, malt, spiced food, and hay-chaff. Such a varied bill of fare is only given to ram lambs, but in bringing out heavy wether lambs the mixture is scarcely less complicated.

Hampshire rams are in great request for crossing purposes for the production of fat lambs and fattening tegs. The Hampshire and Cotswold cross resulted in the formation of one of our best established breeds (*see* Oxfordshire Sheep), but the first cross on long-woolled ewes produced a half-bred which stands deservedly high in public estimation.

Harness (Fr. *Harnois*), in the first instance, means armour and defensive furniture of war, but it is now usually understood to refer to the accoutrement of draught animals whether employed in carriages, sleighs, carts, waggons, or ploughs. The term is not applied to the trappings used in riding, as saddle and harness respectively denote separate uses.

Harness may be extremely simple, and horses have in some cases been attached to their loads by their tails. Its sole object is to connect the animal with the vehicle or weight which he is required to draw. It assumes its simplest form in the collar and chains used in ploughing, and in all cases the shoulder is the part from which the power of the horse is best exerted. It may, on the other hand, be complicated and highly ornamental, as seen in the blazoned and silver-mounted trappings used for high-class carriages. It varies in construction according to the requirements of single and double harness, trace or tandem, or of coaches drawn by four or more horses. There are also descriptions of harness suitable for gun-carriages or hauling timber, and there are parts specially designed for preventing kicking, rearing, or other misadventures.

Leather is by common consent the best material for all these purposes, although chains occupy an important position in some classes of harness. The manufacture of harness constitutes a highly skilled occupation, and is principally done by hand, and is undertaken by harness or collar makers and saddlers. The best harness is hand-stitched.

Lightness, strength, and durability are the most important qualities in harness, but flexibility and comfort are equally desirable. The danger of accidents through weak and defective harness, and the discomfort or actual damage to horses due to misfits, show the importance of good and well-made harness. Among the evils of faulty harness are chafed skin on the poll, over the orbits of the eyes or across the nose, wrung shoulders or withers, sore backs and breasts, rubbed sides, etc. The stuffing of collars and pads should be soft and free from lumps. Harness should not only be well made but constantly attended to, and will then last for a great many years. In high-class stables the harness-room is provided with a stove and appliance for cleaning and polishing the leather as well as the silver and steel of the buckles and bits. The linings of saddles and pads are carefully brushed and aired in order to keep them clean, soft, and free from moths, and soft soap and compots are at hand for the traces and leathers to keep them pliant and in good order. Well-kept harness is the coachman's pride, and is preserved free from dust or damp, protected by curtains or glass, and is frequently taken to pieces and constantly inspected. Such attention is impossible and would be unnecessary in farm stables, but the neglect of cart harness is too often culpable, and contrasts very unfavourably with the care bestowed upon it in the harness-room.

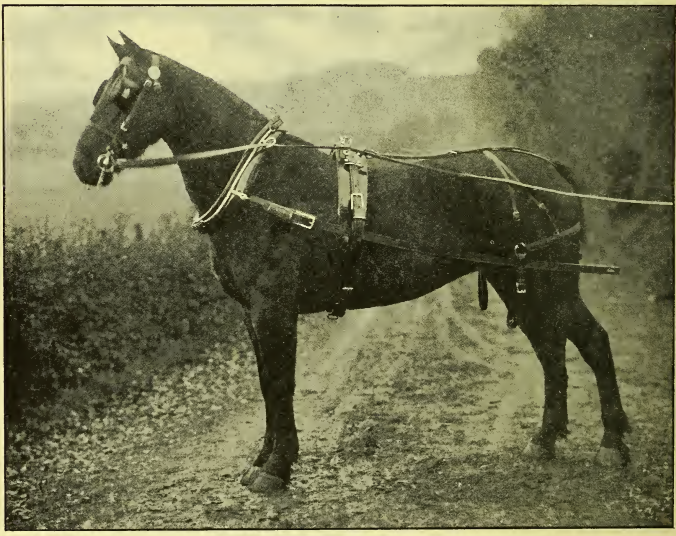
It is not our object in the present connection to describe either the make or the management of high-class harness as seen in the establishments of the wealthy. It may, however, be observed that in all classes of harness the general arrangement of the parts is similar, and is not interfered with by the introduction of silver plates, armorial bearings, or gay rosettes. The same general description of the essential parts is applicable to all classes of harness, although, as already stated, some forms are extremely simple. Although plough and farm harness are plain and comparatively inexpensive, accurate fitting and careful stuffing or padding are just as necessary as in the case of show trappings fit for Hyde Park or Regent Street. Still more so is this seen to be the case when it is remembered that a really good farm horse is of greater value than the majority of carriage horses. Harness always sets off a horse, and many "pairs," which would scarcely deserve to be so described when stripped, match wonderfully well when fully dressed in uniform.

In order to understand harness, it is necessary to describe the various

parts which compose it, and in doing so we shall take farm harness as our type.

The simplest form is plough or "G. O." harness, in which a back-band and chains are the characteristic parts, with bridle, collar, haims, and plough cords. These are all that is necessary, for a crupper strap is not only needless, but burdens and overloads the animal. By loosening and detaching the haims from the collar, plough harness may be stripped off in a moment, and the horse then appears in bridle and collar.

Cart harness is much more complicated. In purchasing harness, it is not, however, requisite to buy duplicate parts. Collars and headgear are common to both cart and plough harness, and may be used for both descriptions of work. They can be included in a full list of cart harness, but need not appear again as parts of plough harness. It is, however,



Gig Harness.

customary on large farms to provide harness for the roads, or for delivering produce in towns, and in this the teamsman takes great pride. This is known as "best" harness, and is provided with polished haims, rosettes, brass mountings, etc., and entails a complete set of everything.

The headgear, bridle, or mullen consists of (*a*) a poll strap which passes behind the ears, and is buckled on either side to (*b*) two cheek straps which end in rings to which the bit is linked; (*c*) a strap and buckle which passes under the throat; (*d*) a front strap which passes over the forehead; (*e*) an ornamental piece fitted to the centre of *d* and *a* assists in giving firmness to the structure; (*f*) blinkers; (*g*) the bit, which passes through two rings which carry the bridle proper for controlling the animal; *d* and *e* often carry brass ornamental fittings, and the blinkers

may also carry brass plates. The headpiece, or, as it is commonly called, the bridle, is unconnected with any of the other harness.

The collar is the first piece of harness placed on the horse. It is usually closed, but may be hinged and open with a strap and buckle at the narrow or top end. In collars for working bullocks it is always open on account of the horns and larger heads of these animals. The collar is made strictly to measurement, and must fit accurately so as neither to be too large or too small. It must adjust itself exactly to the shoulders, and be so lined and stuffed as to distribute the weight regularly. A badly fitting collar causes sore shoulders, as does also a dirty collar. It may cause stoppage of the breath, or what carters term "shutting the wind," in which case the horse may fall, and this is most likely to happen when he is taking a load up-hill. The draught is entirely taken from the

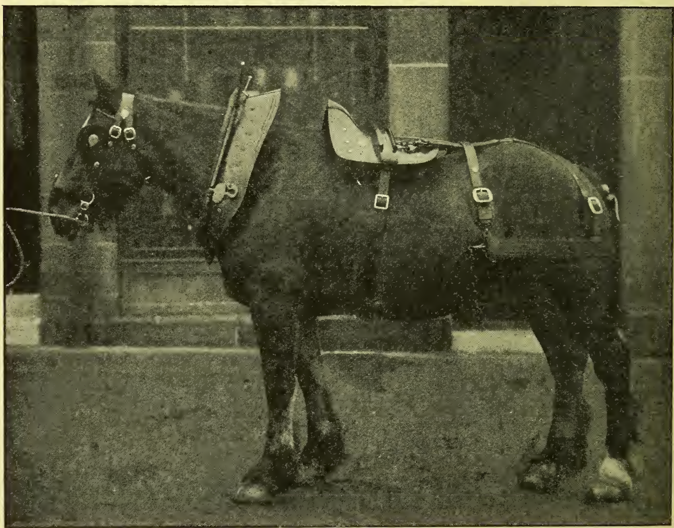
Plough Harness.

collar by the harness and tugs. It is furnished with a deep groove for the reception of the haims behind the outer rim.

The haims are made either of bright iron or wood. In the case of carriage harness they are plated. They are connected with a strap or chain below, and a haim strap above, and are securely braced to the collar, and prevented from moving by the groove before mentioned. They carry the tugs which are attached at the proper height for securing a direct line of draught from the horse's shoulder to the load. In ploughing, the theoretical "line of draught" lies between the attachment at the haims and the point of greatest draught in the plough, and the actual line of the plough chains should correspond with the line of draught. The collar and haims may be considered as the most essential parts of the harness, so far as draught is concerned.

Traces are not usually employed in cart or plough harness, as "tugs" or short chains are used in the former, and plough-chains in the latter. They are, however, always an important part of "trap" and carriage harness, and consist of strong, stitched leather thongs, extending from the haims to the whipple-tree or attachment behind.

The cart saddle is necessary for supporting the weight thrown upon the back of the horse, and is replaced in carriage harness by a pad. It consists of an upper portion of wood and leather, provided with a rigid groove in which slides the back-band. This is a chain which attaches to two hooks in or about the centre of the shafts or limmers. It is kept in position by the belly-band. Underneath, it is stuffed and lined so as to fit comfortably on the horse's back. It, like the collar, should be kept brushed and dry, and should be carefully looked after, or may be the



Cart Harness.

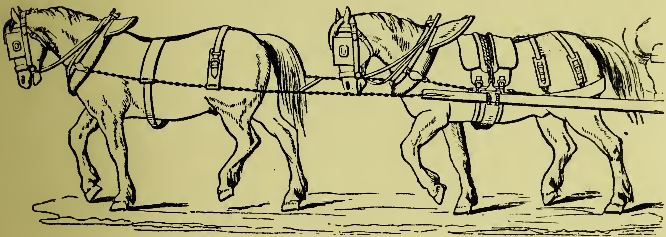
cause of galls. The weight on the back should be as little as possible and in a well-trimmed load should not be constant. The weight on the back is readily ascertained by lifting the shafts at the front-end, and by noticing the degree of tightness of the back-band.

The breeching is attached to the back of the cart saddle by an iron loop, and is placed on to the horse with it. It consists first of a broad and strong leather back-strap which extends to the croup, but not to the tail or under it. It terminates in a pad and ring, and gives support to the actual breeching which goes round the buttocks or hams, and is provided with chains which are connected with the shafts. The breeching is kept in place by a middle cross strap which passes through a loop in the back-strap, and by two stout straps at the croup-end which are stitched to the breeching, and keep it steady. The object of the breeching is to keep back the load

down-hill, and prevent it from touching the horse's hindquarters. It may be dispensed with on level roads, and is unnecessary for ploughing or harrowing. Cart harness therefore consists of four parts. First, a head-piece and bridle for controlling the animal; secondly, collar, haims, and tugs for drawing; third, cart saddle for supporting the load vertically; fourth, breeching for preventing the load from pressing on the horse's quarters when going down-hill.

Housing is a protection from the weather, and is especially meant for preventing driving rain from penetrating between the collar and the shoulders. It is of various forms, sometimes rising into a high crest of circular form, but oftener consisting of a flat and broad leather shield which extends above and behind the top of the collar.

Trace harness consists of bridle, collar, and haims. From the collar it is continued as a long and broad leather back-belt terminating in a loop which passes under the horse's tail. This belt is provided with a long loop in the middle, through which passes the belly-band, and with a second cross strap, through which pass the chains from the haims, back to the stretcher.



Trace Harness.

The chains are carried past the stretchers, and are then attached by hooks to the cart shafts.

Double harness is used for waggons, and requires double shafting. It may also be used with a pole, in which case "collar-bows," or straps from the head of the pole to the lower side of the collar, are necessary to support it.

Reins are an essential part of harness in all circumstances, and to drive on the public road without them is an indictable offence. They may be of leather for road work, but more generally take the form of cords.

Durability of harness.—Good harness will last for many years if taken care of, and keep its value with little depreciation, as may be seen at sales of farming stock. The writer is now using harness which bears the initials of his predecessor, from whom he took it on, over thirty years ago. It is oiled and looked over by the "collar maker" twice a year, and an old-standing contract is in force for keeping up all the farm harness.

Contracts for repairing harness.—The best plan with regard to keeping up harness on farms is to have it done by contract. These contracts do not include new parts, but only necessary repairs upon a stated number of sets, or of horses. The contractor looks over and cleans the harness usually twice a year, but his bill will include brushes, combs, cart grease, and work done on extra harness, all of which items need to be checked. The actual contract may therefore fall a good deal short of the annual expenditure.

In the writer's own case the contract appears moderate. It entails a yearly cost of 15s. per horse, and once in seven years a complete set of harness of best quality with brass mountings bearing initials is supplied gratis, and the oldest set of the same is removed. According to this system no new harness is ever required, and the entire team is kept well furnished. This is in the county of Wilts.

Adjuncts to harness.—Among these may be mentioned leather head-stalls and hempen "shanks" with clogs. They are required for each horse, and add to the initial cost of a stable. Nose-bags ought also to be provided, and are generally made of cocoa-nut matting, bound with leather and furnished with straps. They are in daily use on the land and in journeys, and entail a small annual cost. The money is, however, well spent, as a "feed" in the middle of the day is conducive to health. In many cases they are not used, and during the winter months the teams work without food from yoking to their return late in the afternoon. Nose-bags should be filled with chaff, shredded roots, and corn every morning, and taken to the field; and experience shows that when this is done few cases of colic occur. Taking the contract and all the accessories likely to be required from the harness-maker into account, the annual cost should not exceed 30s. per head per annum, and this may include sundry repairs to belts of machine and other small items outside the stable.

Bullock harness.—In some parts of England bullock teams are employed, and the old yoke may still be seen. They are cumbrous and antiquated as well as unnecessary, as they may be replaced by collars hinged at the bottom, and opening at the top.

Cost of new harness.—The best harness is made from good ox leather, and costs from 50s. to £5 a set, according to the purpose for which it is required. As, however, collars and headgear need not be provided in duplicate, the total is reduced. A full set of cart harness will cost as follows:—

Headgear and bridle with brass mountings	£0	10	6
Collar	0	11	0
Housing	0	9	0
Haims, brass topped	0	10	0
Reins	0	4	6
Cart saddle and trapping	2	15	0
	£5	0	0

Plough harness costs much less, if the same headgear, collar, and haims are used, and all that is then required are the back-band and chains with a pair of plough cords, and these will not cost more than 15s. On the other hand, a full set of plough harness, including all the items necessary, will cost the above-mentioned amount of 50s. Harness ought to be light but strong, and will be found to weigh about 40 lb. in the case of plough, and 50 to 56 lb. in that of cart harness.

Harrows.—The simplest form of harrow is the bush or brush harrow. Long growths of underwood with the brush retained are held together at the butt-ends in a simple wooden frame. When drawn over the land the brush scratches down the soil. It is not of much service for general purposes, but may be effectively used for covering in grass and clover seeds; and it is useful for harrowing pastures and meadow land in the spring, though by no means so effective as flexible iron harrows.

Wooden-framed harrows are rarely made now, steel or iron being better suited for the purpose; however, there are still considerable numbers of them used in many districts, though even in the most conservative they are gradually disappearing. On very light soils, where it is not desirable to cover the seed too deeply, and where iron ones could not be made sufficiently light, wooden harrows are preferable for covering seed, and a set of six seed harrows linked together covering 16 feet upwards, drawn by two horses, does work which is best suited to the conditions. Apart from this, wooden harrows are not nearly so effective or so economical to work as are well-constructed iron or steel harrows; they are heavy in draught, the arrangement of tines is generally such that one will often follow exactly in the track of another, leaving portions of the ground unaffected, and they are very liable to jump and oscillate, so that the work is indifferently done; still on heavy land they were, for some work, better suited than were most of the heavy iron harrows made up to thirty or forty years ago, but the curve-tined iron drag harrows which gained popularity then, and the sickle-tined harrows of more recent years, are decidedly superior, for these latter draw into the soil by the curved pitch given to the tines, whereas the wooden ones were mainly dependent upon their dead weight to make the tines catch the surface.

Iron harrows became popular when Armstrong invented the zigzag frame which allowed the harrows to be drawn directly forward and parallel with the draught pole (instead of diagonally, as in the case of the wooden harrows), and at the same time ensured that each tine necessarily took its allotted share of work, leaving no portion untouched. Practically all rigid framed harrows are made on the zigzag principle, except some of the modern spring-tined ones, where parallel bars are used, but in these the tines are generally set in the same formation as where the zigzag frame is used.

Iron zigzag harrows are made in many sizes, from those where a three-harrow set drawn by one horse is used to cover seed up to heavy sets requiring three or four horses to level down furrows on heavy land in the early stages of the preparation of the seed-bed. Ordinarily the tines are straight, though sometimes they are slightly curved; but where the tines are short the liability to accumulate weeds and so lose their effective scratching powers, entailing frequent hindrance for cleaning, is intensified when they are curved, otherwise the curved would be more efficient. Straight tines have a consolidating effect, where curved tines have a lifting effect, and therefore leave the seed-bed lighter.

Drag harrows, usually made with a lifting handle, and with slightly curved tines, either sharp or duck foot, effect good work, but they lack the power to adapt themselves to surface inequalities, and from their weight are difficult to lift when it is desired to free them from weeds. On clean land they are well suited to break down furrows or to stir soil lying coarser than would allow smaller harrows to do good work. Sometimes large drags are mounted on wheels with a raising attachment, and are called wheeled-drag harrows. It is usual to define a harrow as an implement without wheels for working down the surface by scratching; and a cultivator as one carried on wheels; the wheeled-drag harrow is therefore more strictly a cultivator with short and frequent tines. This, too, is giving way to the more effective modern cultivator.

Sickle-tine harrows, in which the principle of the vibrating curved tine is used, are met with rather frequently, but they have not attained so much popularity as the cultivators which are made on the same principle; this is probably because the ordinary zigzag seed harrow answers its purpose very

satisfactorily, and for many purposes is preferable to the sickle-tine. In the earlier stages of the preparation of a seed-bed, however, excellent work is done by the sickle-tine harrow, but in that case it is used rather as a substitute for the drag harrow than the seed harrow.

Flexible harrows, that is harrows which have not a rigid frame, but which are made in small jointed sections, allowing each part to adapt itself to the inequalities of the surface, take several forms. They are useful for harrowing pastures, for collecting couch and other weeds on arable land, for destroying annual weeds in young corn crops, and for other purposes, according to the nature of the harrow points or other outstanding parts. The chain harrow, where a system of interlinked rings forming a stout flexible webbing is the principle very commonly employed; round, square, or other shaped links used separately or in two or more shapes, and the angles as they abut, take the place of tines, harrowing and smoothing the surface. More effective harrows for harrowing purposes, if not quite so well adapted to weed collection, are made with spurs or tines. As a rule, these are composed of castings of small sections, which are linked together so that the tines follow the setting of the zigzag rigid harrow. There is considerable variation in design and weight of these harrows, and it is desirable when purchasing to have in mind the nature of the work they will most commonly be called upon to perform, and to buy accordingly. A flexible harrow is necessary on practically every farm.

Hawthorn, The.—The great Rose family (*Rosaceæ*) is easily distinguished among other orders of British plants by the indefinite number of stamens inserted on the calyx. It is divided into three tribes, recognised as distinct Natural Orders by some botanists, namely—(1) *Amygdalaceæ*, the plum tribe; (2) *Rosaceæ*, the rose tribe; and (3) *Pomaceæ*, the apple tribe, to the last of which the common hawthorn (*Cratægus oxyacantha*) belongs. Owing to its general use as a hedge plant, there probably are more hawthorns growing in the United Kingdom than any other kind of tree or shrub.

"*Leaves*, stalked, narrowed at the base, and more or less divided upwards into 3 or 5 lobes or segments, which are irregularly toothed or lobed. *Flowers*, in June, generally white, but sometimes pink or rose, sweet-scented, in sessile corymbs on short leafy branches; petals broad; styles 1, 2, or 3. Fruit red, rarely yellow, globular or ovoid, crowned by the short divisions of the calyx, containing a hard, bony, 1 to 2-celled nut, each cell with a single seed" (Bentham).

Although the wood of hawthorn is of good quality, yellowish-white, fine-grained and susceptible of a good polish, it is not often that it can be had of suitable size for economic use. The tree is planted only as a hedge plant (*see* under Hedges) or for ornament. For the latter purpose it is a great favourite, and can be obtained in a great variety of forms, bearing single or double red, pink and white flowers. There is also a fastigiate variety, which is a beautiful object when in full bloom, and another variety which bears yellow haws. Like many flowering trees, the hawthorn seldom blossoms freely two seasons in succession, and, as the flowers are produced on growth of the previous year, pruning or clipping totally prevents their being produced at all. Perhaps the most remarkable display of old hawthorns in bloom may be seen in the Phœnix Park, Dublin.

The common hawthorn grows naturally nearly all over Europe, and pushes into Central Asia, appearing also in North Africa. In Southern

Europe and Africa a nearly allied species (*C. monogyna*, Jacquin) is more common, distinguished from the British species by a yellow tint on the backs of the leaves, those of *C. oxyacantha* being bluish-green.

Like all trees indigenous to the United Kingdom, the hawthorn has given its name to many places. The Gaelic word is *sceithiog* (pronounced "skyoge," the *g* being hard), and may be recognised in such place names as Skeog, Skeoch, Auchenskeoch, Drumskeog, etc., in Scotland; Skeoge, Aghnaskeagh, Aghnaskew, Drumskea, etc., in Ireland.

The common hawthorn is not particular as to soil, provided it be neither pure peat nor wet clay. Grafting must be resorted to for the propagation of the choice varieties; to raise a stock for hedge-planting, the haws must be treated in a special manner. They should be laid in a heap to rot the pulp, mixed with an equal bulk of riddled earth to prevent heating. There they remain for fifteen or sixteen months, turned over regularly once a fortnight, and the seeds will be fit for sowing early in spring of the *second* year after gathering. They should be drilled rather thinly, and covered with about ½ inch of riddled soil and leaf-mould. The seedlings remain two years in the drills, and are then transplanted into nursery rows, their tap-roots being shortened with the knife, 1 foot between the rows and 2 inches between the plants. In two years more, that is 5¼ years from gathering the seed, the young "quicks" will be fit for sending out as hedge plants.

The continental practice is somewhat different, the haws being sown in drills as soon as ripe, without the preliminary rotting process, and branches laid over the beds, which shelter stimulates some of the seeds to germinate in the first season.

The common hawthorn is the only British representative of the genus *Cratægus*, of which North America alone possesses an immense number of different species. Sargent has enumerated no fewer than 132. Some of these are very ornamental in flower and berry, but none of them attains forest proportions, and none equals our native hawthorn in beauty or abundance of flower.

If it is intended to make use of hawthorn timber, it must be sawn into planks for seasoning immediately after it has been felled, else the wood heats and becomes brittle.

Hay and Haymaking.—Hay may be defined as herbage deprived of moisture to such a degree as to secure its keeping in the rick. Desiccation arrests fermentation and mouldiness, and preserves the aroma and nutrient qualities of the green herbage. Hay is inferior to grass as a food, owing to the fact that the herbage is older when cut than when grazed. Warington points out in his *Chemistry of the Farm* that "young grass is much richer in albuminoids, and contains a smaller proportion of indigestible fibre, than older grass, and is consequently much more nourishing." There is also a rapid deterioration when cutting is delayed, so that not only is young grass superior to old, but early-cut hay (inferior as it undoubtedly is to young grass) is superior to later-cut hay. The well-known fact that hay-cheese and hay-butter are inferior to the grass-made products, bears out this view, and all dairymen know that cows yield a richer-coloured and superior milk when grazing on pastures than when feeding upon hay. It must, however, be remembered that the value of hay is enhanced by the scarcity of natural grass in winter, while the value of growing grass may be depreciated by its abundance during summer. Hay, therefore, is an important winter food, and is often a valuable asset for realisation. It is

consequently of great importance to consider the best conditions for securing hay, and the more so as so many farmers habitually neglect them. As already indicated, early cutting is the first *desideratum*, but even it is controlled in many cases by the weather. If possible, all herbage intended for hay should be cut before it is in full bloom. The maximum nutrient value of all flowering plants is attained before flowering; and during and after inflorescence the constituents concentrate towards the reproductive organs. It is so in the sago-palm and the sugar-cane, in vetches, clovers, and grasses, and all other fodder crops. Vetches before flowering contain 19 per cent. of albuminoids (calculated on the dried plant), but in full flower only 14 per cent. Taking the sum of their nourishing constituents immediately before flowering, they contain 47·5 per cent., but after flowering only 43·4. The nutrient principles in meadow hay follow the same rule, as shown by Warington, for the same hay cut on June 9 and on June 26 was found to have deteriorated in the following respects:—

Date of Cutting.	Albuminoids.	Amides, etc.	Fat.	Soluble Carbohydrates.	Fibre.	Ash.
June 9 . .	9·4	1·8	2·7	43·2	34·9	8·0
,, 26 . .	7·8	0·7	2·7	43·3	38·2	7·3

In this case the loss of albuminoids and the increase in more or less indigestible fibre are the most important points. The temptation to allow crops intended for hay to develop to maximum weight per acre may be resisted by considering the more rapid growth of the aftermath in the case of early-cut crops, and the possibility of a second crop. As to allowing grass to ripen, it is a cardinal error, as the deterioration then proceeds to a point destructive of the whole value of the hay. Such fodder is practically innutritious, and virtually becomes straw.

The changes which take place within the plants affected are common to all. They consist in the concentration of all the albuminoids and fats in the seed, and the gradual conversion of all the soluble cellulose, sugar, and other carbohydrates, into indigestible woody fibre. The same takes place in the case of cereal crops, and may be easily observed in the young shoots of briars, which at first are succulent, sweet, and agreeable to the palate, but as the season progresses they become woody and flavourless.

Haymaking.—As soon as the herbage is severed, haymaking begins without a moment's interval. It is a simple process of drying, but not to an extreme point. The best hay contains from 14 to 16 per cent. of water, or about $\frac{1}{6}$ or $\frac{1}{7}$ of its total weight; and even dry straw contains about the same quantity. The warmth and comfort of hay is not interfered with by this large proportion of water, as it exists in an imperceptible or hygroscopic condition. It is, however, easily driven off by moderate heat in a water oven. The first part of haymaking is passive, for grass and clover require to be exposed to the air until a part of the moisture is dissipated. The remaining operations consist in turning the swaths, or so breaking and distributing the herbage as to promote drying. The methods employed vary considerably in different districts, but all have one object in view. They also vary with the character of the herbage, for grass will stand any amount of tedding and turning, whereas the broad leaves of clover and the narrow leaves of sainfoin are easily detached or crumbled into fragments

which cannot be gathered up. This constitutes the principal difference between making different classes of hay, and so important is it that the different systems employed in securing hay crops are founded upon it.

In making meadow hay no time should be lost in expediting the natural drying process. Immediately the grass is cut, the swaths should be broken and shaken out over the entire surface by the process known as "tedding." It may be done by hand, but is now usually performed by a horse-drawn tedder. This task is particularly suitable for machinery, as it is uniform and should be rapid. The swath is thrown well up into the air by the forks attached around a revolving drum actuated from the travelling wheels by nave gearing. Each fork is furnished with a spring, similar to that of a knife-blade, so placed that it gives to any obstruction it may encounter. The progress is therefore rapid and effective. It is calculated that one of these machines will do the same amount of work as eighteen men. After tedding, the grass is turned by hand or by a second passage over it of the machines, and the secret of good haymaking is the promotion of the quickest drying possible. In bright weather the process may be completed in three or four days, but in catchy or wet weather it is often hindered for weeks. The best hay is made in the sunny days of June and July, without rain, and under the influence of drying breezes. In such circumstances the green colour is preserved almost without change, and the nutrient properties of the grass are completely preserved.

After repeated teddings or turnings, the grass is raked together into wind-rows or "wakes," and these are then broken into cocks, kiles, or "pooks," ready for carting.

The above is a description of haymaking as carried out under the most favourable conditions, when the *minimum* of labour is required. It must, however, be allowed that such conditions are rare in our uncertain climate. Not only is this the case in the south and east of England, but to a still greater degree in the northern counties in Scotland and in Wales.

As is well known, the rainfall on the west side of these islands is much heavier than in East Anglia and the east of Scotland. Also in mountainous tracts the fall is often excessive, and renders haymaking extremely precarious. It interferes with early cutting and postpones carrying week after week. Instructions from books therefore become to a great extent impracticable, and in some cases, in spite of all precautions, the hay is seriously damaged or rendered worthless.

It is to guard against such misfortunes that various practices are introduced into haymaking, most of which are peculiar to certain counties and districts, and do not tend to become universal. Many of the processes employed in the humid climates of Cumberland, Westmoreland, or Cornwall, involve too much labour for application in the drier climates of Hampshire, Surrey, and the eastern counties. This accounts for the fact that in these latter districts more hay is ruined in bad seasons than in those in which the farmers know what to expect. Climate controls the practice of haymaking, as, for example, "cocking." The hay-cock is an institution in the northern and less favoured counties. The farmer is never content until he sees his hay "off the ground," by which is meant, into cocks. Cocks are made with care, so as to throw off the maximum amount of rain—rather smaller at the base than the top, pointed, or high crowned. The grass is got together into cocks as soon as it is judged to be dry enough, and long before it is ready for carting. The principle is to "cure in the cock," and, as opportunities occur, the cocks are opened and spread into staddles, which are closed up again before night. When once in good-sized cocks there is little danger

of damage, but as a further precaution they are swept together and built into "pikes" or summer ricks, containing about one load each. These pikes are seen dotted over the hay fields of the north of England awaiting an opportunity for carting to the stack. They are carefully constructed, brought up to a point at the summit, and cross-roped with two hay bands. As showing the generality of the system, it may be mentioned that the appearance of the first hay pike is said to silence the cuckoo. These pikes are never seen in the south of England, and the hay is there generally left abroad on the ground, until it is raked together for carting.

As to the comparative merits of the two systems, it has often been urged that better hay is made in cocks than when extended over the ground. The hay is safe from rain, and is not bleached by exposure. On the other hand, the cocking system is distinctly slower and more laborious, and south-country farmers cannot be persuaded to adopt it. Besides, in fair weather there is no evident advantage, and the consequence is that in climates where fine weather is the rule, the quicker and cheaper method is preferred. Still, it must be allowed that cocking is safe, and that the best hay is made where it is practised. Middlesex haymaking has often been held up as a model. In this grassy county there is an inducement to produce good hay for the London market, and in all published descriptions of the system employed, the hay-cock figures as an important feature.

Haymaking in Wet Seasons.—Sufficient has already been written to show that cocking is a safeguard against injury from wet weather. The difference is so great between a fine fortnight, in which the hay is harvested without difficulty, and those long stretches of rainy weather which interrupt the hay harvest indefinitely, that we must consider the nature of the damage so often incurred, and the best means of avoiding loss.

Postponing cutting is a common course, and is often successful in districts where fits of bad weather are short-lived. It, in a word, consists in "waiting till the clouds roll by." Others do not wait, but trust to the fact that freshly-cut grass sustains no damage from being wet, any more than do freshly-cut flowers. There is also the deterioration in the quality of the herbage to be taken into account, which warns us that postponement may easily be carried too far.

Grass and any herbage intended for hay should not be moved after cutting when rain appears imminent. The swaths may lie for several days under pouring rain without injury. It is the half-made hay which suffers, and hence the wisdom of leaving the grass fresh and untouched.

It was pointed out many years ago by the late Dr. Voelcker, that every blade of grass is provided with a waterproof mantle, and that it is desirable to keep the same intact and without injury. Turning and handling rupture the outer cuticle of the herbage, and not only tend to allow water to soak into the grass, but also promote fermentation of the juices through rupture of the cells and mixing of their contents. It is therefore clear that the wisest course is to leave the swaths alone until the weather changes. Heavy swaths should be inspected at intervals, as in warm moist weather they are liable to become yellow next the ground, and, as soon as this is observed, they should be gently turned over. In proportion as the grass dries or parts with its sap-water, so does the danger of damage increase. Half-made hay has ceased to be impervious, and becomes susceptible to the drawing or solvent effects of soft water. It, in fact, begins to yield an extract which is known, when purposely made for stock, as "hay-tea." Boiling water acts on hay precisely as it does upon tea-leaves, and rain produces a similar effect, if in a less degree. The soluble matter is removed

and lost, and the hay is reduced to an indigestible and innutritious mass. It also becomes the victim of fungoid germs, which cause it to turn black and fusty, and after a few days the crop is destroyed.

By a judicious postponement, first of cutting, and then of breaking the swath, these evils may often be averted. It is, however, impossible to guard against continued wet weather, for haymaking is essentially a summer operation. Even cocking cannot be done in the rain, but in showery seasons it would be well to adopt the methods used in areas of heavy rainfall.

Ensilage offers so simple and effective a plan of dealing with grass and clover in wet seasons, that it is surprising to notice how little it is followed. Instead of worrying over grass spoiling in the rain, it would be wiser to put on all the available strength of the farm, and get it into silage clamps as fast as it is cut. Rain makes no difference to silage, and the fresher the herbage is got together the better does it keep. The writer speaks from experience, as during the wet summer of 1907 he took this course, and the result was most satisfactory. Cattle greedily eat silage, and the material comes out of the clamps in excellent preservation, being almost too firm to cut with a hay-knife (*see* Ensilage).

Carting or carrying.—The quality of hay depends a great deal upon the way it is stacked. It may be carried too soon or too late, the first error resulting in overheating, and the second in loss of flavour and in looseness of truss. In order to come well out of the rick, it must be carted at the right stage, although this may appear to be a mere truism. It is, however, only too true that a vast amount of hay is spoilt every year by injudicious carrying. It is a matter of judgment and experience. If hay is carried when damp from rain it moulds, and it is therefore of importance that it should be carted when entirely free from external moisture. Sap-water is altogether different. If the hay retains an excess of natural sap, it will heat and possibly may become black, or even fire, but it will not mould. There should be sufficient sap moisture to secure sweating in the rick, and the consequence will be a rich brown colour, a compact truss, and an agreeable hay-like aroma, due to slight fermentation. When hay is well put together, the heat generated is very perceptible, and may rise to a point which causes the hand to be quickly withdrawn. This is often found to be the case, and sometimes becomes a cause of anxiety. It is, however, better that the rick should show signs of heat, than that it should remain quite cool.

If danger is apprehended, steps may be taken to avoid it. Alternate layers of hay and dry oat straw may be used in some cases. A ventilating shaft is easily formed by stuffing a sack tightly with straw and drawing it up through the hay as it is built around it. Cross-ventilation to this shaft may be secured with the help of hurdles placed aspar from the centre to the outsides of the rick.

The idea of cooling heated ricks by means of a fan blast applied so as to draw out the hot air does not commend itself, neither is the principle sound. To allow of the gradual escape of heat by breaking the continuity of the heated mass is one thing. To draw air through a heated rick only promotes oxidation, and increases the evil. There is nothing more calculated to cause a conflagration than opening an overheated rick, and exposing its contents to the air. Ricks often show signs of having heated to a dangerous degree when they are cut into. This is indicated by extensive black spots in which the hay is carbonised at the focus, and gradually becomes normal in colour towards the circumference. In such cases, which are very common, the rick must have been in serious danger; but as long as air is excluded it

survives the ordeal and gradually cools down. The difference between brown and green hay is entirely one of comparative heating, and a nut-brown colour is characteristic of good clover hay. Heat in ricks is caused by fermentation, controlled by the exclusion of air, and limited moisture. If air and moisture are both present in too great abundance, the temperature rises to the point of ignition, and the rick fires. In a properly regulated "sweating" or heating, alcohol, ethers, and volatile oils are formed, which give the pleasant aroma and flavour to good hay.

The composition of hay varies with the herbage from which it was derived, the stage at which it was cut, the success in making and ricking it, and the land upon which it was grown. Hay is classified as old, new, coarse, fine, meadow, clover, sainfoin, trefoil, mixed, and ryegrass hay (bents), and the price varies on the market from 60s. to 90s. or 100s. per load of 18 cwt.

The chemical composition varies with the quality, and is shown by the following analyses by Wolff:—

Description of Hay.	Water.	Ash.	Albuminoids.	Crude Fibre.	Extractive Matter free from Nitrogen.	Fat.	Total.
Clover hay, poor . .	15	5·1	11·1	29	37·7	2·1	100·0
,, medium .	16	5·3	12·3	26·0	38·2	2·2	100·0
,, good. .	16·5	6·0	13·5	24·0	37·1	2·9	100·0
,, very prime	16·5	7·0	15·3	22·2	35·8	3·2	100·0
Meadow hay, poor .	14·3	5·0	7·5	33·5	38·2	1·5	100·0
,, medium .	14·3	6·2	9·7	26·3	41·6	2·3	100·4
,, good .	15·0	7·0	11·7	21·9	42·2	2·2	100·0
,, very prime	16·0	7·7	13·5	19·3	40·9	2·6	100·0
Linseed-cake . .	11·5	6·7	27·3	9·2	35·3	10·0	100·0

Mechanical Appliances in Haymaking.—Within the memory of living farmers the instruments employed in haymaking were all of archaic character and stereotyped form. They might be called classic in respect of their antiquity, and barbaric in respect of their simplicity. They consisted of scythes, forks, wooden rakes, a bag of spare teeth, as these were constantly dropping out, carts and waggons; and beyond this simple list of rural tools, mostly home-made and home-repaired, no others were required. The contrast between haymaking in 1840 and haymaking in the present time is very great so far as appliances are concerned; but the operation remains substantially the same in its objects. It must not for a moment be supposed that better hay is made now than then, and it is by no means improbable that the product of hand-labour was in every respect as good as now. The advantage of machinery lies in the greater rapidity and cheapness with which the process is carried out, rather than in any actual improvement in the material produced. Separate articles will be found dealing with the various farm implements employed in haymaking, so that descriptions are here unnecessary. It is sufficient to mention the multifarious instruments now seen at work in an up-to-date hay field. It may, however, be mentioned incidentally that the full advantage of machinery can only be realised on large holdings, and that it is one of the tendencies of such improvements to place small farmers at a decided disadvantage. A description of these modern labour-saving machines would occupy a considerable space, and we therefore proceed as briefly as possible to only notice them.

The horse-drawn grass-cutter has been brought to wonderful perfection of simplicity, lightness, and efficiency, reducing the cost of cutting from 6s. or 7s. per acre to about one-third of these amounts. The *hay-tedder* was in the field almost if not simultaneously with the cutter, and is a powerful aid in the making of meadow hay, although not applicable to clover. The *swath-turner* is now generally used, especially when crops are heavy, or in the case of clover hay, as less liable to injure the leafy herbage than the swiftly-revolving forks of the tedder. The *horse-rake* has taken the place of the wooden hand-rake, not without objections; for horse-raking carries stones into the rick, which are serious obstacles to chaff-cutting, and even to cutting out trusses for sale. This objection applies to arable rather than to meadow land, which is always free from stones. The *hay-sweep* may appear in the form of American hay-rakes or other adaptations for drawing the wind-rows and small cocks rapidly to the rick. It is an old idea, practised long before the introduction of special instruments for the purpose, by the simple use of a waggon-rope crossed, so as to grip the hay at the point of intersection. A horse attached to the doubled rope at each side of the load completed the appliance, and two men with feet on the lower rope and hands holding the upper rope, regulated and gave effect to the simple expedient. The *loader* is intended to save the cost of hand-pitching. It is simply a shortened elevator, attached behind the waggon, and carries up the hay to the top of the load upon the same principle as in the straw stackers. The *stacker* is simply an adaptation of the ordinary elevator, and is commonly employed at the hay rick. *Stack covers* or awnings mounted on poles and cross poles protect the growing rick from sudden storms of rain, and patent thatch may be used instead of hand-drawn "yelms" or "steeps." Thus from first to last haymaking may be carried out by mechanical contrivances, at a minimum expenditure of paid labour.

The Cost of Haymaking.—Nothing varies more than actual cost. In fine weather with light crops it may be small, and in reverse conditions it may be both heavy and vexatious. Haymaking is more liable to interruption from the weather than corn-harvesting, and is therefore less capable of being reduced to a money statement of costs. Hay is probably as expensive to secure as corn, which latter cannot be accomplished much under 12s. per acre in favourable circumstances. Taking into account the various circumstances of haymaking, the cost probably falls lower and rises higher than corn-harvesting. It has been stated to have been done for 7s. per acre, exclusive of horse labour; but the wear and tear and depreciation of machinery, as well as the cost of horse labour in the height of summer, are difficult to assess. If the grass is cut, tedded, raked or swept up, loaded and stacked with appropriate machines, the cost ought to be reduced at least one-third below Morton's estimates for the period of 1868, which varied between 10s. and 20s. per acre (*Hand-book of Farm Labour*). It may indeed be doubted whether there is any advantage in attempting to form estimates of cost, as they cannot be depended upon from year to year, and the operation of haymaking must be carried through when once undertaken whether costly or the reverse.

Measuring Hay Ricks.—The density of hay varies from 9 to 14 cubic yards to the ton. In well-made ricks when the hay has heated sufficiently, and omitting extreme cases, about 10 or 11 yards may be assumed to represent a ton; in looser ricks 12 or even a larger divisor. The rick is for practical purposes measured as to length, breadth, and height, the latter dimension being taken from 6 inches above the ground to about 1½ or 2 feet above the eaves. The rest of the top is thrown in. The three

dimensions are multiplied together in terms of yards and decimals of yards, and the product is divided by 9, 10, 11, etc., according to estimate. In measuring the length and breadth, at least 1 foot should be omitted at both ends of the tape, and thus tops, bottoms, and outsides are all excluded, and the rick reduced to cubic measurement.

Hay and Sheaf Sheds.—The hay shed is now in most districts rapidly becoming a recognised item in the list of buildings that constitute a British farm homestead. This is especially the case in the south-west and west of Scotland and in the west of England. Elsewhere in Britain the hay shed is not so much in evidence. In the parts referred to more hay is made and consumed at the farms than in the other districts. It is wetter there, too, than towards the eastern side of our country. And, generally speaking, in the former the farms are smaller and fewer hands are about. For these reasons alone has the hay shed come to be looked upon as a necessity almost by the farmers of the localities we have mentioned. With them the hay harvest is usually a more important part of the routine of the farm than the corn harvest. It is certainly more apt to be affected by the fickleness of our climate. Cut corn will stand more rain than cut grass intended for hay can. Anything therefore that leads to convenience in effective storing of the hay as it comes into order is a boon to the farmer who has it in hands. He who has a shed at his disposal can deposit the stuff therein without having to trouble further about protecting it from rain. He can deal with it in detail without having to protect each day's produce as the farmer who has no shed has to do. And after the crop has been secured the farmer with the shed has no more trouble with it until the time arrives for its being dealt out to the animals, while the other has to set about the thatching of his.

It is clear therefore that the farmer having a hay shed is at considerable advantage over his fellow who has not anything of the kind. Not only is the farmer more favourably placed during hay-making and at the final ingathering; when it comes to the consumption of the hay he is on better terms then as well. He can break bulk when and wherever he thinks best, without troubling over the consequences. There is the roof over all to keep off the rain, and should the place be exposed the windy side will be boarded in such a manner as to keep the wind from blowing away the loose hay. Matters are different, however, with the stack or rick. When one breaks into it rain and wind are liable to work damage if care be not taken to make good the breach. This is easy enough when only occasional cuts are taken from the rick; but not very practicable when it is daily being applied to. Wind and rain lead to loss—not to speak of untidiness—under these conditions. When the shed comes in, however, there in nothing of this. There may be untidiness with it as well as without, but there is not the same liability to loss from wind and rain. All the year through, then, does the hay shed place the farmer who has the use of it at an advantage over his neighbour who does not own one.

Though the hay shed is now beginning to be recognised as a necessity, it is still to a considerable extent looked upon as a luxury in so far as the business relations between landlord and tenant go. The former does not regard it in the same light as the main buildings of the homestead. It is not such a solid and permanent construction as, say, the barn. In consequence he is apt to think that it is an affair of the tenant's alone. At any rate we rarely hear of the proprietor taking upon himself the burden of

providing hay sheds for the farms he owns. In a general way, we see the business carried out as a joint one, each party contributing in a proportion definitely agreed upon. The landlord sometime provides the material, and the tenant erects the shed. Or each may pay a half of the cost of the completed shed. Or the proprietor may bear the outlay and charge the tenant interest thereon. Hitherto it is seldom that the tenant has borne the cost of the shed himself, unless, of course, when he was guaranteed the unexhausted value thereof should he break connection with the estate while such value existed. Now, however, he is by law at liberty to put up erections of the kind, with the assurance that he will be duly protected in this way. He must first, of course, give the proprietor notice that he intends to do such a thing. But failing the proprietor being able to prove that such a step is not in the interests of the farm, and on his declining to take part in the proceeding, the tenant may, as we have said, set about the business himself, without fear of loss through after confiscation of any rights of property he possesses therein.

The wise proprietor will no doubt come to realise when the time has arrived at which the farmers in the district where his land lies are likely to derive material benefit from the possession of hay sheds, and prepare to meet them half-way in the matter. There is no use in going to the expense of stone and lime and slate in the erection of these sheds. Stone and lime pillars and gables are, in fact, too clumsy in this connection. We want the pillars to be as light as is consistent with strength, so that as little room as possible may be taken up by them. Brick pillars take up less room than do stone ones, but they are lacking in the power of resistance against lateral thrusts, and in some situations it requires a considerable degree of stability to stand up against the wind as it beats against the broadside of the shed. Either wood or iron pillars or posts are the most suitable for the erection of the hay shed. Fortified concrete pillars (concrete with iron rods embedded therein) may eventually come to be used in some localities.

There are few estates that cannot show trees suitable for the posts of hay sheds. Larch is the best for the purpose. It stands exposure well, whether treated with a preservative or not. Good larch is scarce now, however. Failing it there is usually Scots pine to be had. This if well grown will stand duty for a long time as a hay shed post or pillar. Dressed with creosote or some other reliable preservative, it does not come far short of unprotected larch in this respect. Oak, provided it is free of sapwood, will stand longer than either, but the outer inch or two of any tree suitable to use as a shed post is of this nature and begins to decay ere long, thus loosening the joints between it and the parts of the erection that are attached to it. And to reduce a big tree until its sapwood has been removed and only sound heart of oak left is too expensive a process, even should there be a sawmill on the estate capable of tackling the job to be taken in hand. Sweet chestnut is better than oak, in respect of handy sized trees having less sapwood round their circumference and at same time yielding wood that has considerable powers of resistance against weather.

On the generality of estates there are no doubt trees of one or other of the sorts above mentioned available for use as posts for hay sheds, and where such can be turned to account it is a simple matter to reserve them for this purpose. It is advisable to strip the bark from the trees before they are placed in position to bear up the roof of the shed. The remainder of the wood can in most cases also be procured from the growing timber on the estate. There is sure to be abundance of spruce about. The trees may

not, however, be of sufficient size to yield the wall plates and struts required. If they are the wood will prove good enough for the purpose. Spruce wood unless dressed with a preservative will not stand exposure to weather, but in the parts of the shed where we are inferring that it will be used it will be protected from rain, and air will be free to play upon it—a state of matters that leads to long life where wood is concerned. Silver fir, if available, is preferable to spruce. It yields long clean timber very suitable for the framework of the roof of such an erection as we are dealing with. And Scots pine will answer this purpose too.

The utilisation of timber on the estate for other parts of the hay shed than the posts and pillars implies, of course, the existence of a sawmill in connection with the woods. Where such is not available, imported timber has to be procured. Indeed this is nearly always done, notwithstanding the presence of a mill on the estate. It is well known that unless home converted timber be properly seasoned it is bad policy turning it to account for building purposes. On the majority of estates, however, there is so much of the hand-to-mouth way of working in connection with the sawmill, that it is impossible under the management this implies to anticipate the wants of a year or two in advance, to the extent of laying aside some converted timber for future use to be seasoning during the time. Under the circumstances there is nothing else for it but to fall back on foreign wood. There is no reason, however, why the estate sawmill cannot be so managed that where suitable wood is available, converted timber for such purposes as the erection of hay sheds cannot every year be turned out with a view to future requirements. If properly stored and occasionally looked after, it will for the first year or two keep on improving. Good home-grown wood so dealt with may indeed be safely turned to account in repairing the more substantial buildings of the homestead.

Once in position, the wood which constitutes the framework of the roof is safe from immediate harm at the hands of weather. It is protected from rain, and wind is more or less free to bear upon it. The pillars or posts are more exposed. Rain frequently beats upon them. The sun cracks some of them, thereby giving rain a better chance to cause harm to them. So long as they remain sound, however, and the surface cracks are not very pronounced, rain will not do the posts much harm. It runs off at once, and the post dries shortly after the rain ceases. But there is no difficulty if one is so disposed to fortify the posts by means of paint or tar or some other preservative. Where practicable, creosoting is effective.

It is when the post comes in contact with the ground that it is most liable to suffer from rapid decay. The first 9 inches or so beneath the ground is the critical point of endurance of a post of wood stuck in the earth—whether it be shed post, gate post, or paling stob. Deeper down in the ground the wood is not so hardly put to it. It is wetter there, but more shut off from air. Between the wet and the dry, so to speak, it is at the mercy of the natural agencies of decay. There the bacteria which lead to the decomposition of organic matter are free to go about their business. Moisture and air being both requisite for their existence, they have enough of each at the point we indicate, consequently wood, unless it be of a stubborn quality, soon succumbs to the effects of such a trying position. Larch and oak and sweet chestnut woods are, as we stated above, hardy in this respect, but even they in time begin to be affected by the cause referred to. Encasing the part of the post underground in Portland cement concrete is an effectual preventive against decay of the wood thus situated; therefore for all the extra cost this implies, it is wise to do this

with all the posts of wooden erections. It is wise economy to do the same with gate posts.

The post should be set on as well as in concrete, however. Safeguarding it at the critical point might be considered an ample precaution to take. Certainly a collar of cement placed round the part of the post likely to suffer most would go a long way to preserve the post from rot at that particular point. But the fact of the end of the post—the underground part—being nearly always wet, while the upstanding portion is at all times comparatively dry, leads to more or less ascent of moisture through the body of the post. This upward passage of moisture is bound in time to tell on the woody fibre of the post. Thus even where the end of the post is surrounded by concrete, but not set therein, it is sufficiently in touch with the subsoil for moisture to affect the whole post in the way we have indicated. An extra shovelful or two of concrete is all that is required to make sure of a longer life to the post than it is likely to have when such is denied to it. A thoroughly well creosoted post might be set up without the accompaniment of concrete. We would prefer it with concrete, however.

With pillars and sawn wood for the wall plates and the framework of the roof all forthcoming from the estate, there is only the corrugated iron-sheeting, the ridging, and the rhones or eaves-gutters and conductors to go outside for. That is if we are to adopt the ridge-roof form of shed. Better than it, however, is the circular-roofed shed. With the latter one can do away with the cross ties that are essential in the other. In a shed of the

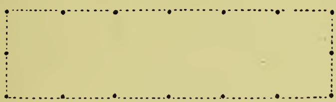


Fig. 1.

kind we are discussing, these ties are in the way when it is being filled. They hinder, if they do not altogether prevent, the action of a mechanical fork when the hay is being stowed away. And when the hay begins to settle down of itself, it catches on these ties and thus throws undue strains on the roof as a whole. In the case of the curved roof we can adopt a T iron girder bent to the curve of the roof as an effective truss or main couple. With one of these over every pair of posts, as in Fig. 4, well fastened to the wall plate by means of a suitably contrived shoe, we have a sufficiently rigid skeleton to hold the shed together without the aid of cross ties, and to bear the strain from the working of an overhead fork as well. The pillars must, of course, be stout and sound, and be set at least 3 feet in the ground; and the wall plate must be strong and be firmly fixed to the heads of the pillars. The wall plate should be strutted too, as Fig. 2 shows. Light purlins may then be fastened to the girders, to the former of which and to the wall plates the struts can afterwards be securely attached. The rhone hooks can be fastened to the wall plate, and the rhones themselves and the relative conductors be fitted up at any time thereafter.

In the Figs. from 1 to 4 we give the plan, elevation, and sections of a good substantial shed of the kind just referred to. A shed of this description need not be less than 24 feet in width. And one may as well have it 16 feet high from ground to top of wall plate. The length is, of course, more a matter of circumstance, depending very much on the size of the farm and the amount of hay in demand at the steading.

In many situations it is considered advisable to board up the shed all round, access being gained by means of large sliding doors. A shed finished in this way keeps tramps from sheltering therein. Such an arrangement saves waste, too, should the site of the shed be a very exposed one, as we have already hinted. And when different kinds of live stock have more or less of a free run of the homestead, it again prevents waste of hay. It is mostly, however, at the west country dairy farm that there is a desire shown to have the hay shed closed at sides and ends. There the shed is placed in such a position that the cows can be fed directly from it—the girls carrying the hay from shed to byre as it is wanted. Under these circumstances it is obviously an advantage to have the shed enclosed in such a way that when the doors are shut no loose stuff can be blown out, and no passing animal can toss it about and lead to its waste. At many places, however, it is practicable to dispense with this addition to the shed, if not indeed wholly, by at least shutting up the side or the side and end that are most liable to catch strong winds. Where live stock alone have to be guarded against, this can be done by a little judicious fencing. But in all cases is it advisable to board in the first 2 feet or so down from the wall plate. About this point the hay is never tightly packed—it is apt sometimes, indeed, to become open as the hay settles down—consequently rain is liable to get in. Of course, the gable ends, down as far as the wall plates, are always closed, no matter how the rest of the building is treated in this way. Fig. 2 shows the shed finished

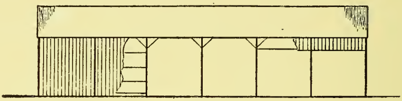


Fig. 2.

partly one way and partly the other, and a portion without any side boarding.

When the estate is not self-supplying in the matter of posts and wood framing, one may as well adopt the shed constructed entirely of iron at once. Capital sheds of the kind are now on the market. The columns are of steel sunk in concrete blocks let into the ground. These support wall plates and roof trusses of a girder form which affords strength with lightness, and allows ample headroom, all cross ties likely to be in the way thus being dispensed with. Sheds of this description can be shut in wholly or in part as one chooses, it being an easy matter to fix the corrugated sheets to the sides and ends. Cross bars are fixed to the pillars, and the sheets are attached to them with bolts and clips easy of manipulation.

A galvanised iron erection is a garish thing to set up in the country, but a coat of red oxide paint tones it down wonderfully, and at same time adds a long time to its life. Even when the roof alone of the shed is of iron, it should be dealt with in this way. If the roof of the composite shed be finished in this way, and the wood be dressed with some suitable preservative, the erection ought to have a long life before it.

Coming to the sheaf shed, we need hardly spend much time in pointing out the advantages it confers on the farmer who has such at his disposal. Be harvest time wet or dry, a shed of this kind at the homestead means a saving of time at that critical season. It is easier work building sheaves in a shed than forming them into a round rick with a conical roof. The

builder has no need to concern himself over the finical business of so adjusting the taper of the roof that it will throw off water. He can carry on the ordinary method of packing the sheaves together until the roof of the shed comes in his way, and hints to him it is time to begin on ground level with another cross tier or bay. When the shed has been filled in this way there is no more to do—no time has to be spent in preparing thatch and fixing it up thereafter,—all the time the unprotected corn running risk of a drenching, which often happens to the unthatched rick. And at threshing time one can without more ado break in on the contents of the shed; then, as at harvest, he can begin or leave off operations at any time without fear of the sheaves being exposed to the weather, as they are in an unfinished stack.

The hay shed is, as we remarked above, a more important matter to the west country farmer than to the east country farmer. It is *vice versa*, however, in the case of the sheaf or corn shed. The one uses more hay than the other and has less corn to handle. The sheaf shed is not, as yet, much in evidence, however. But ere long there will in all probability be a loud enough demand for it. Its advantages as an economiser of material as well as a saver of labour are so apparent, that it is almost certain to become in time an accepted part of the buildings of the farm. Besides, what is

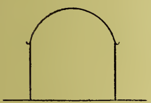


Fig. 3.

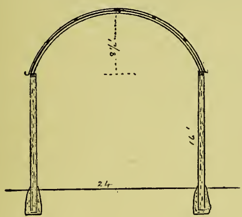


Fig. 4.

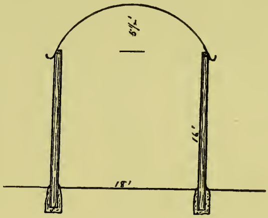


Fig. 5.

there to hinder the sheaf shed or sheds being turned to account during a wet harvest as sheaf driers? An affair of the latter sort has more than once of late proved a good friend to the farmer, by enabling him to dry off much of his corn which he would otherwise have been compelled to see gradually going to ruin out in the open under pelting rains. With sheaf sheds in which to string up the sheaves in rows until dry enough to keep in bulk, the farmer would be able to save a great deal in fair condition, which under other conditions would be certain to be spoiled.

A less substantial affair can do as a sheaf shed than for a hay shed. The sheaf shed need not be so wide, a point which enables one to do with a slighter framework for the roof. Indeed, one can dispense with this framework altogether. Making the shed 18 feet in width would allow us to do without any framework of the kind. With strong posts sunk between 2 and 3 feet in the ground (the ends in concrete as above), and a strong wall plate firmly attached to these, trusses and purlins may be omitted altogether. The curved iron covering well bolted to the wall plates will in most situations prove rigid enough to hold its own against a gale. Fig. 5, which gives the section of such a shed as we are referring to, shows what we mean. We leave a fair amount of headroom under the curve, thereby increasing the capacity of the shed, and at same time lessening the outward thrust on the wall plates. A piece of galvanised fencing wire

stretched over the roof from each pillar to the one opposite securely fastened to both will help considerably to strengthen the roof against assault from the wind.

Where the estate is self-supplying as regards the woodwork of hay sheds of the description we are dealing with, these cannot be very expensive otherwise. The corrugated sheets will require to be purchased; and rhones and conductors as well, seeing they could hardly be dispensed with. And perhaps boarding for 9 inches or so down from the eaves—for the reason mentioned in connection with the hay sheds; and for the gable heads. With the posts spaced at 9 feet apart, 9-inch by 3-inch wall plates would be strong enough in themselves to do without struts. At wide spaces, however (they might be widened to 12 feet), struts from the pillars would become a necessity. It is best when these can be done without. They offer more points for decay to start from. Lighter posts answer in the case of the sheaf shed.

When money is being spent in the erection of sheaf sheds, it shows indifferent management when they are so placed in relationship to the other buildings of the farm, that full advantage cannot be taken of them as savers of labour in respect of the staffing of the place. There is nothing to prevent them being arranged in such a way in relation to the threshing-floor that the minimum of labour may be expended in conveying the

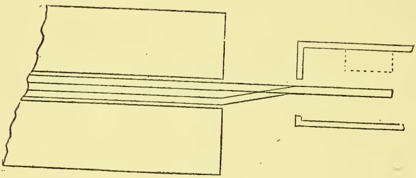


Fig. 6.

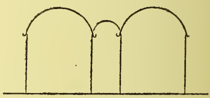


Fig 7.

sheaves from the shed to the mill. Arranged in pairs, as we show in Fig. 6, what is there to hinder the sheaves being run direct from the shed to the side of the feeding board of the mill in hand bogies? A very light railway would serve the latter. The whole business might be carried on by women, leaving the men and horses to attend to tillage work. There are now on the market simply arranged overhead single-conductors for the passage of pulleys bearing loads of a fair weight which can be pushed along by hand or drawn by mechanical power, which are even more suitable for the purpose aimed at than rails and bogies. A glance through the catalogue of the Coburn Trolley Track Manufacturing Co. will open any enterprising farmer's eyes to the possibilities there are of saving the labour of the homestead by the use of the overhead trolley rail.

Where a home-thresher is hardly ever in use, and the threshing is done by the itinerant mill, room for the latter can be left between the sheds in order that it may be near to the sheaves, and at same time be close to where the threshed straw can be stored until required—the straw taking the place of the sheaves.

The narrow space between the pair or pairs of sheds erected to suit the home-thresher can at very little expense be roofed over, as in Fig. 7. Nothing but a single sheet and light wall plates with holdfasts to attach them to the shed posts is requisite for this. In fact, this can hardly be left

out of account in this arrangement of the sheds. In the case where the mill is to be admitted between the sheds, the increased cost involved is prohibitive so far as regards the simple kind of erections we are dealing with.

Hazel, The.—*Corylus*, a genus of few species belonging to the *Carpineæ*, a branch of the great family of *Amentaceæ* or catkin-bearers. The common hazel (*Corylus avellana*, Linn.) is indigenous in all parts of the United Kingdom, in all parts of Europe except the extreme north, in Central and Russian Asia, and in North Africa. It is a bush or small tree. *Leaves*, alternate, broadly ovate or orbicular, doubly toothed, pointed. *Flowers*, monœcious, the male and female being born in separate catkins on the same plant. The male catkins are drooping; they are formed in summer on the previous year's growth, and remain closed during winter, having broad sessile scales with two small lobes or adherent scales inside, and about eight stamens inserted on the scale without any perianth. The female catkins are small and budlike, formed of closely packed, narrow scales, whence early in spring protrude a bunch of bright crimson stigmas. Ovary two-celled, with a pendulous ovule in each cell. *Fruit*, a hard brown nut, enclosing an esculent kernel. The inner scales of the female catkin grow rapidly while the nut is forming, protecting it with a tough leafy involucre with jagged ends extending beyond the nut. There are several cultivated varieties, such as the filbert, cobnut, etc., but they differ from the wild type only in the greater size of fruit and leaves. There is also a garden variety with purple leaves.

The hazel grows well on every description of land that is well drained, but a chalky subsoil is said to be particularly favourable to the quality of the rods. It endures a considerable amount of shade, especially in the southern counties of England, where it forms the commonest undergrowth in oak woods and mixed plantations. But it is no longer of the economic value it formerly possessed as coppice, when it was in great request for hurdle-making, hoops for barrels and making charcoal, the rotation being from twelve to sixteen years. It is still one of the favourite woods for walking-sticks and alpine staves. It may be propagated from seed, but the quickest and most effective way of getting up a stock is by layers.

Hazel-nuts formed an important part of the food of the primitive inhabitants both of these islands and the Continent, as may be seen from the vast quantity of nut-shells found in the refuse-heaps of British and Swiss lake dwellings. It is not surprising, therefore, to find the plant commemorated in many place-names, such as Haslemere, Hazelwood, etc., in English, and, from the Welsh and Gaelic *coll* and *calltun*, such names as Calder, Cawdor, Calton, and, in the aspirated form, Auchenhill and Barwhill.

Nuts are still in enough request to make the cultivation of filberts a profitable branch of market-gardening in the southern counties, especially in Kent. The plants intended for fruit-bearing are propagated by suckers, grafts, or layers, the last-named being preferred by growers in the Maidstone district. The layers become ready for removal in about a year; they are then kept in nursery rows for two or three seasons, when they are ready for planting out in autumn, allowing a space of about 10×8 feet for each bush. The soil must be well drained and free, the manure most highly esteemed being old woollen rags (Williamson, *Trans. Hort. Soc.* iv. 145). Root-pruning is recommended in the third year after planting, and bearing

should begin in the fifth or sixth. Williamson states that in 1819 he gathered 2 cwt. of nuts from fifty-seven bushes, mostly six years old, growing on 360 square yards of ground. English cobs or filberts are quoted at present (November 1907) at 3½d. to 4d. per lb. wholesale.

Heather and Heather Burning.

". . . . Blue heatherbells
Bloom'd bonny on moorland and sweet rising fells."

From time out of memory poesy and sentiment have clustered around the word heather. Of the Scottish peasantry, and those in particular whose destiny has led them to distant lands, this has always been characteristic. Nothing more forcibly recalls their love of the "old country" than recollections or reminiscences of its flowery moors, with their joys of bracing air and exercise, and exceptional opportunities of contemplation of nature. A sprig of heather in flower from a Scottish hill sent to one of these "exiles" invariably rekindles memories of days gone by, and, it may be, of voices and hands which long have been still. Even in the families of Colonial Scots who have never seen a Highland moor, this adoration of the heather is often observed. A kindred feeling may frequently be recognised among young Americans and British Colonials with regard to the genius of Sir Walter Scott and Robert Burns, many of whom, though they have never seen Edinburgh or Abbotsford or Ayrshire, possess a knowledge and appreciation of the works of these great Scotsmen which would put to shame that of thousands who have been brought up in the land of the nativity and the atmosphere of Scott and Burns.

But the present object is not to dilate on the poetic or patriotic love which so many cherish for the free and beautiful heather, but to examine its uses from a utilitarian standpoint. In latter days great tracts of heather, of which there are many millions of acres in the Highlands of Scotland and Wales and in some parts of England and Ireland, have come to possess no mean economic value. Let us see what this value is, and especially let us consider how it may be best developed and conserved.

The plant with which we are concerned, ling or common heather (*Calluna vulgaris*), is of the Order Ericaceæ. There are many varieties, but for the present purpose this one only need be considered, namely, the ling which, with its rosy flower, thrives in most situations, but rejoices in peat, sand, and sunshine.

Although the uses of this common plant have in the present day become more valuable than before, there are evidences that it nevertheless, or at least the land which produced it, was not altogether without value centuries ago. For example, John Major, who flourished in the latter part of the fifteenth and earlier part of the sixteenth centuries, who studied at Cambridge and Paris, and has been described as "a storehouse of all the learning of mediæval times," in a description of Scotland (1521), says, "Heather or bog myrtle grows in the moors in greatest abundance, and for fuel is but little less serviceable than juniper." Major, who wrote in the Latin tongue, says he is constrained to coin a Latin word from the vulgar tongue for the plant, because he does not fancy it to be found in Italy. The coinage here referred to is the word *Haddera*, which seems to have "caught on," for we find it used by Jamieson, alternatively to heath or heather, in his *Dictionary of the Scottish Language* (ed. 1808). Major

continues: "Some of our countrymen suppose the land on which this plant is found to be worthless and barren, but I, on the other hand, look upon it as eminently valuable and fruitful ground. The plant, when dried after the manner of juniper, makes excellent fuel, and I much prefer it to coal; but just because they have the thing abundantly they hold it cheap. Under this plant and in its neighbourhood the pasture for cattle is such that you shall find none better." What John Major's claims to be considered in his day an economist or agricultural expert may have been, although he is described as a "storehouse" of mediæval learning, history sayeth not. But the probability is that the common moorland heath was not of much economic value till the last quarter of the eighteenth century, and did not attain to anything approaching its present value till sixty to eighty years later. It is of greater value now than at any previous date.

The present value of good heath land arises from two sources, namely, from its uses for pastoral and for sporting purposes. Little pastoral or agricultural use was made of the enormous tracts of mountain and heath-land in Scotland (which at present extends to 9,061,504 acres—Agricultural Statistics, 1907) till the eighteenth century, and it was not till towards the close of that century that it was found that even the highest lands in the Highlands afforded most valuable grazings for sheep. Before that era the only use these grazings were put to was the support of a limited number of Highland cattle, the annual sales of which Sir John Sinclair (*Agricultural Reports*, vol. iv. p. 185) calculated did not exceed £300,000. The systematic introduction of sheep farming to the Northern Highlands according to the Border Highlands system revolutionised the agricultural system of the Northern Highlands, and brought into use and profit an immense extent of territory, which, in this view, was as much an addition to the economic resources of the country as if the land had been recovered from the sea.

In consequence of this, and simultaneously with it, the practice of heather burning became a necessity, and was carried out with more or less system, but often with the greatest ignorance and excessive and needless destruction of valuable grazing. Some sixty to eighty years later, when the attractions of shooting wild game, especially grouse and deer, came into vogue, and with it a keen demand for heathery moors, the practice of heather burning received a further stimulus. Then, for the first time, it was perceived that this operation was one of the first importance,—that the reckless and unintelligent happy-go-lucky method of burning which had hitherto prevailed ought to be abandoned, and a more rational and careful system, fitted to reproduce a full and regular supply of sound and succulent heather, should be adopted.

In this process it was perhaps inevitable that some friction between the adherents of the old and the upholders of the new and improved system of burning heather should have arisen; and, sooth to say, many misunderstandings between the grazing and the shooting tenant of the same lands, and bitter feuds between the shepherds of the former and the gamekeepers of the latter, forthwith arose, and continued till a comparatively recent date. Now, however, these differing views have been in great measure reconciled, partly through improved estate regulations concerning heather burning, but more largely from better informed views of the operation, which have led to a perception that, rightly considered, the interests of the farmer and the sportsman do not really to any appreciable extent conflict and should not lead to discord. What follows is intended to support this view of the matter.

The practice of heather burning in Scotland is legalised and regulated

by the Act 13 George III. c. 54, which repealed certain previous statutes about the same matter. The date of the superseding Act was 1773, which roughly corresponds with the general introduction of sheep-farming in the Northern Highlands. The Act provides that muirburn or heather burning shall be legal only between 1st November and 11th April, but that this period may be extended to 25th April on application to the Sheriff by the proprietors of "high and wet Muir lands." The penalties for infringement of this Act are £2 for a first offence; £5 for a second offence; and £10 for a third and every subsequent offence; with the alternatives, in case of non-payment of these fines within ten days, of imprisonment for six weeks, two months, and three months, for successive offences. Prosecutions of this kind are now rare, though it is feared that technical breaches of the Act are not uncommon, especially in deer forests, where, speaking generally, few grouse and no sheep are to be found, and it is sometimes believed—mistakenly, I think,—that muirburn need not be systematically attended to.

Differing views have been held in the past and to a certain, though greatly diminished, extent, are still held as to (1) By whom heather burning should be undertaken—by the proprietor or the grazing tenant, or conjointly by these. (2) At what age heather should be burnt. (3) How much should be burnt in a single season. (4) By what methods should burning be done, and under what preferable conditions. (5) Whether it is more desirable to burn heather early than late, within the open season, or whether the extended period should be availed of. (6) What should be the effects on sheep and grouse of well-regulated heather burning? These considerations comprise and cover the whole theory and practice of heather burning.

The first of these questions has been at the bottom of the misunderstandings and trouble which in the past so often arose, and which occasionally still arise, about heather burning. Initial neglect of a clear understanding at the outset of the lease, or, more probably, laxity in implementing such conditions as may have been made, have encouraged the shepherd or the gamekeeper to suppose that he was the only or the chief factor in the matter. The sheep farmer naturally takes his shepherd's view, and the gamekeeper is backed by his master, and when that situation is brought about, foolish and destructive action by the one party or the other not infrequently ensues. Unquestionably control should remain principally with the landlord, not that he should be enabled arbitrarily to dictate to his tenants the periods, methods, and extents of the burning of heath, but that he should hold the balance fairly in the event of there being any difference of opinion or contention between his tenants or their servants on the subject. In practice some such arrangement as the following has been found to work smoothly. The tenant who desires to have heather burnt notifies this to his landlord or his factor, and names a day or date when, weather permitting, he proposes this to be done, whereupon the proper estate official notifies the tenant if he be a farmer, that the estate keepers, and other assistants if required, will be on the ground at the appointed time to meet the shepherds and proceed with the burning in terms of the conditions of tenancy. The same course is followed in the case of notification proceeding from the sporting tenant or occupant.

Not a little diversity of view prevails among shepherds and gamekeepers and others concerned with heather burning as to the age at which heather should be burnt, or beyond which it may not be advantageously retained. But in reality it is impossible to give forth a hard-and-fast rule for this aspect of the subject. What would be a prudent determination for one

district, or for an individual case in any district, might be highly improper if applied to other areas of heath in the same district, and would be the prelude of disaster very probably in another district. The one important object of heather burning is the economic improvement of the subject, whether for farming or game rearing, and it is obvious that this must be influenced by considerations of altitude, exposure, climate, and soil, which all have an important bearing on the growth of heather plants as on all forms of vegetation. Heather is also believed to be favourably affected by its proximity to the sea.

In the north of Scotland, and especially in the north-west, regrowth of heather is slow, often extremely so, and it is therefore doubly important that in this area the time for burning should be skilfully chosen and effectually executed, so as to excite reproduction with all attainable quickness. If in these districts heather is permitted to live to an excessive age, and to grow to an unusual height and denseness, before being burnt, it is greatly to be apprehended that the regrowth will fail altogether. In such cases vigour has been declining for years, seeding has been defective, and roots as well as stems having partially decayed; the only means of restocking these places with heather is the slow and uncertain one of deposit of seed from adjoining lands. We say uncertain, because in such cases the bared ground is not infrequently possessed by ranker and less useful vegetation than heather, especially by the ubiquitous and pushful bracken, of which more will be said below. On eastern slopes heather generally grows better, and retains its natural freshness and succulency longer than on western slopes. If general rules of guidance as to the age limit of useful heather were attempted to be laid down, they would, in the view of at least a large majority of practical men, probably include the following. Burn all decaying or injured heather when decay or injury from frost or otherwise occurs. Burn some parts, the oldest and least valuable of course, in each year, so that in a rotation of ten, or in some cases twelve, years the whole ground will have been overtaken. But burn more frequently good growing ground. Where the heather on damp, deep ground can be burnt, do not hesitate to do so oftener than on dry slopes, for heath grows much more rapidly on the former. You can hardly have too much young fresh heather if you can reckon on steady successive supplies of it. Nor need shepherds ever fail to burn as often as they can, or at least every third year, the "slacks" and slopes of dry white bent grass, which so much prevail on some estates, and which, in that condition, are positively deleterious to all animals. Unfortunately, this is an operation more difficult of attainment than might be imagined, for it is not often that the "slacks," or familiar wet hollows around the hard knolls of heather, become so drained and dry as to carry the flames. In this connection it is proper to add that where, as is often the case, these rough sheltered hollows contain the wild cotton plant which is so useful alike to deer, sheep, and grouse, owing to its early sprouting, burning should be avoided or very sparingly exercised.

The question of the extent of heather which should be burnt in a single season is also one about which varying views may quite naturally be held, but is to some extent determined by what has already been said in regard to the age limit of heather, and the periods of recurrent burning. The extent to which burning may be necessary, or may safely be carried, on a single farm or estate, may greatly exceed that which, under proper conditions and results, may be practised on another. Soil, climate, altitude, and many other elements enter into this problem. If a standard must be laid down in

leases, a fair proportion—which is now very commonly adopted—is one-tenth yearly of all the aged or decayed heather, which, it will be observed, is not commensurate with one-tenth of all the heather on the farm, much less with all the ground or full extent of the farm. But one-tenth of the "burnable," that is old and decayed heather, is generally quite as much as can be achieved in any one season on any one farm. Not infrequently it proves to be more than can be overtaken, owing to unsuitable weather, even when resort is had to the extendable period, that is between 11th and 25th April. In cases where the stipulated area is short burnt in any year, it is usual on well-managed estates to increase the area burnt in the succeeding year to an extent equivalent to the shortcome in the previous year.

More important perhaps is it by what methods and under what conditions burning should be done, than by whom it should be controlled, or what extent should be fired in a single year. Here at least uniformity of practice is possible. The same methods are, within limits, applicable to all moors. The one aim of management of heather is or should be the provision and preservation in a healthy and vigorous condition, and in regular rotation or succession as regards age, of an abundant supply.

Around this part of the question there have been contentions also. A common fault of proprietors and their gamekeepers used to be that they burnt too little heather—far too little; and an equally frequent practice of farmers and their shepherds was that they burnt too much when they had the opportunity; and by both parties burning was conducted with little discrimination. They set forth for the hill on a fine day when they considered the moor dry enough to burn, and set a light to the first rank-looking piece of heather they came to. They let it burn while they had a talk over their pipes, and when they considered that the flames had devoured enough they put it out. As long as the fire did not run into a wood or catch a wooden fence, everything was "all right" (in their opinion), but as often as not they had let the fire run over some nice little stretches of young succulent heather which had been submitted to the same operation only a year, or perhaps two or three years before. This is an example of burning without intelligence; but nowadays both gamekeepers and shepherds are far more alive to the fact that both grouse and sheep, and, it may be added, deer also, require their heather in as nearly as possible the same state or stage of growth or age, and that a regular provision of heather is necessary—it may be said indispensable—to them all.

Whether burning should be done in strips more or less narrow or in numerous small patches, not far apart, and surrounding or adjacent to tracts of fresh and useful heather, is a minor question. The former plan has been advocated as best for game and grazing animals alike, while grazing tenants have often contemned these as useless or insufficient, and have desired and adopted, where they could, burning in great patches of 60 to 100 acres, or even larger. On this point the following observations of one who has had a lifetime's experience of heather burning may be quoted:—"The smaller and more numerous patches of heather are burnt the better. This applies to both sheep and forest ground. The burning of large patches should be put down with a firm hand, except in the case of ground that has been neglected, when wholesale burning of old and useless heather is the shortest road to a better state of things, and as the young heather comes on it should be broken up into smaller patches and brought into a regular rotation. The object of heather burning should be to provide the best possible supply of food for the different seasons, a thing that can never be done by firing a whole hillside."

Infinite injury has often been done to the interests of graziers and sportsmen alike by indiscriminate and excessive heather burning. Shepherds have been more frequently accused of this than any other class, but it undeniably occurs in the hands of gamekeepers too, especially in deer forests, where the care of heather is too often practically ignored. These catastrophies occur either accidentally, or when the head of the forest wakes to the consciousness that deer as well as other animals wintered in such places must have heather. One or two stalkers are set to work on an unbroken hillside armed only with a box of matches, and with perhaps no provision for controlling the fire which it is so easy to start. In such cases which sometimes, it is feared, happen on sheep and grouse land as well as in deer forests, the fire stops not till it has exhausted its fuel, and has swept to destruction not only hundreds of acres of ground vegetation, but often valuable standing trees and other property.

In this connection reference must be made to innumerable cases of destruction of young trees as well as valuable heather alongside railways by the emission of sparks from locomotive engines. Although the cause of these fires was obvious enough, it was found, until very recently, that there was practically no recourse against the railway companies. Formerly the companies were entitled to plead in the case of a claim for damage, *first*, that they used their locomotive engines under statutory powers, and, *second*, that in their use they had observed every contrivance and reasonable precaution against the emission of sparks or cinders from the engine. The companies were not obliged to prove this; the onus of disproving it lay with the claimant; and almost invariably there were insurmountable obstacles to doing so. Now, however, under the provisions of an Act commonly called the "Sparks" Act, passed on 4th August 1905, but which only came into operation on 1st January 1908, "to give compensation for damage by fires caused by sparks or cinders from railway engines," the railway companies can no longer put forward the foregoing pleas. "The fact," says section 1, sub-section (1), "that the engine was used under statutory powers shall not affect liability in an action for such damage." It may be expected that this change of the law adversely to railway companies will lead to more precautions by drivers of locomotive engines, and fewer destructive fires from that source.

Where practicable, the best form for burnings of heather is somewhat lengthy strips of from 30 to 60 yards in width. Where from the quality or conformation of the ground this system cannot be followed, it answers almost equally well, and equally can be done with less chance of the fire escaping control, to burn in numerous small separate areas of 3 or 4 acres each. This is undoubtedly the best way of maintaining a constant and fresh supply of young heath suitable for all animals which feed upon it. For game propagation and preservation more particularly, these numerous isolated patches should be ranged round the most sheltered and sunny slopes where broods can lie and feed in comfort. Damp is much against young grouse, as it frequently produces cramp and disease. Therefore it is sometimes well that dry slopes should be left unburned for shelter to young broods of grouse where the adjacent land is soft and wet.

Whether heather burning should be followed earlier or later within the legally appointed period may be thought a comparatively minor consideration, but it is not without importance. The occurrence of a spell of dry weather, perhaps accompanied with black frost, in November or December, presents a temptation to get some of the season's burning over at once. But it is not always wisdom to yield to the temptation. Early burning

may be, and often is, succeeded by periods of frost, and if in the interval there is sprouting of young heather it is liable to be nipped by these frosts. On the whole, opinion is pretty general that later burning, say between 10th March and 11th April, is best; it is not only safer than very early burning, but is believed to result in earlier feeding from the recurring heather. But it frequently happens that in March and the early part of April suitable weather for heather burning is wanting, and may not even be found before 25th April, after which date burning cannot be legally prolonged. The solution of this question of early *versus* late burning is attended with difficulty, and may be best left for decision as circumstances are found applicable to individual cases.

Whether on all farms or moors or deer forests a quantity of long heather should always be kept in stock for wintering purposes during oncomes of heavy snow, is rather a vexed point. Many keepers and shepherds insist on this being done; others will not have it, for they say not only does very long heather get borne down by the weight of deep snow, but such heather, being so old and sapless, is, when it becomes the sole food, deleterious, and causes heavy loss then or later. Probably after heather has attained a height of 15 to 18 inches it is of little further use, and should be burned, and heather 9 to 12 inches high is likely to be more serviceable in a snowstorm both to sheep and grouse than much taller and ranker heather. Very tall and coarse heather is more commonly met with on deer forests than on sheep grazings, or on the border of woods, or within growing woods. In the first case this arises from sheer neglect, and in the latter two from fear of the fire bursting from control and entering and destroying the wood. But by careful management, and having a strong force of helpers, and burning only during a favourable wind, fringes along the outsides of woods, and even within them, may be burnt without injury to the timber, and be of great advantage to the grazing.

In all heather burnings it is generally prudent, to prevent the fire obtaining mastery, first to have a narrow strip burnt against the wind on the further or lee side of the area to be burnt, before setting fire to the main body of the heather on the windy or weather side. Or when the wind is high or variable to burn only against the wind, starting from a burn or some other obstacle to the fire spreading behind. When a runaway fire occurs, all the men available except one should be massed some distance in front of it to create a bare strip by tearing out heather, or to prepare some other obstacle to its further progress, and the odd man should be occupied in extinguishing sparks or rekindlings of fire in the rear. It is not at all an easy matter, however, thoroughly to destroy very old long heather, although it is not difficult to eradicate young heather from such areas. The foliage and twigs of rank woody heather may be consumed, while the thick and tough stems refuse to go at one attempt.

Mention may be made of the improved heather burning lamp which is now in common use in place of the primitive "box of lucifers," or the tow and paraffin. By aid of this lamp a vast deal more heather can be burnt in one day than by the laborious process of striking innumerable matches. This lamp is simply a small cylinder or tank filled with paraffin oil (capacity about 1½ pint), with a spout and wick protruding on one side and a long wooden handle on the other.

No notice of heather burning in the present time would be adequate without a reference to what has been justly described as the "Curse of the Bracken," which is rapidly spreading all over the lower and middle altitudes of our Highland and Lowland hills. All the commoner weeds which afflict

the agriculturist appear in cycles, waxing and waning and reappearing in a given period. They, moreover, have their favourite lodgments, and do not obtrude themselves everywhere; but the bracken—possessing some grace of form it must be admitted, but sadly worthless for any economic purpose—is perennial and ubiquitous. It is rapidly capturing and injuring, not only great tracts of pastoral land in every Highland parish, but is attacking and throttling thousands of acres of valuable heather. The invasion of this worthless plant has indeed become a very serious fact, but no one has yet devised any effective remedy either of prevention or cure. The bracken may be slain, of course, by purely mechanical means, but the extent of the evil, and the difficulty and expense, and in some cases impossibility of this operation, render it prohibitive on all but very small holdings. It is a debatable point whether this baneful rise of the bracken is due to the withdrawal of cattle from these lands as the staple stock, and the substitution of the lighter sheep, or perhaps in some instances from there being no stock at all. Somewhat acute discussion may be heard in the present day of the point whether grouse do better on land stocked with sheep, or on land where there are no sheep. Many authorities whose opinions are entitled to full consideration do not hesitate to say that the former proposition is the correct one. For this view, one of the reasons assigned is that it is just on land which is cleared of sheep that the bracken makes uncontrolled advance among good heather, and threatens to obtain the mastery. There are other reasons, no doubt, such as the manurial help which heather receives from sheep, and loses from their absence. Certain it is that the constant presence of a moderate stock of sheep on a moor militates not against successful production of grouse and other winged game.

People may be met who say, why not burn out this pestiferous plant? They know not the vigour of the bracken—nor the depth and penetration of its roots. Burning of the bracken simply promotes its regrowth by providing a manurial stimulant.

In ancient times there was a belief that the burning of fern brought on rain, just as the belief that burning of heather induces rain is widely entertained in the present day. This belief, as regards the fern, is illustrated by a curious letter written by the Lord Chamberlain of the period (1636) to the Sheriff of Staffordshire, which shows that even His Majesty King Charles I. was not free from it. It is as follows:—

"Sr.—His Majesty taking notice of an opinion entertained in Staffordshire that the burning of Ferne doth drawe down rain, and being desirous that the Country and himself may enjoy fair weather as long as he remains in those parts, His Majesty hath commanded me to write unto you to cause all burning of Ferne to bee forborne until His Majesty be passed the Country. Wherein not doubting but the consideration of their own interest, as well as his Ma[ties] will invite the country to a ready observance of this his Ma[ties] command. I rest, Your very loving friend, Pembroke and Montgomery. Belvoir, 1st August 1636. To my very loving friend the High Sheriff of the County of Stafford."

Landowners in Scotland, especially Highland landowners, shooting tenants, and grazing tenants, to say nothing of the multitudes who belong to none of these classes, but are nevertheless keenly interested in the preservation of the "bonny blooming heather," will not willingly be parties to its injury or extirpation. A delight to all, it is to them besides a source of wealth, or the means of most pleasurable relaxation and sport. It would

be hard to say how much the prosperity of all classes hangs on the sport of which heather is the basis, and on the important agricultural industry into which it so largely enters. Every year appears to add to the reality and the magnitude of this. Very much therefore depends on good treatment of our extensive heaths, and in the foregoing pages an effort has been made to state and illustrate the best means to that end, though necessarily many details have been omitted.

Hedges.—The common hawthorn is the tree almost exclusively used in the United Kingdom for hedges intended as fencing on agricultural land, and it never disappoints the planter, provided that the land is not water-logged, the one condition that this most hardy plant demands being a well-drained soil. For the method of sowing the seed and raising the young plants, technically called "quicks," *see* under Hawthorn. The usual way of planting a hedge is on the bank-and-ditch plan, which should

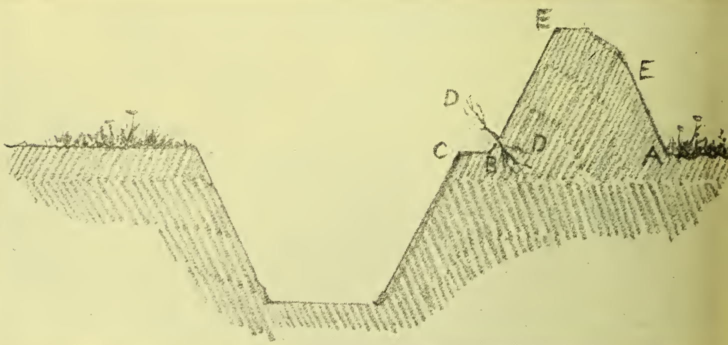


Fig. 1.—Section of Hedge and Ditch with Bank.

be set about in autumn. Having pegged out the line of the intended hedge, one side of the ditch is cut with a ditching-shovel, the sods being laid upside down to form the base of the bank A B, leaving a level space B C (technically called the "scarcement") between the bank and the edge of the ditch, and preparing a bed for the quicks D, a few inches above the natural level of the ground. Having cut one side of the ditch, the foreman or forester lays the line afresh 4 feet from the former line and parallel to it, and the outer or field side of the ditch is then cut in the same manner as the other, the sods going to add to the bed for the quicks, which are now laid in about 1 foot apart on the prepared bed, the roots being covered with pulverised soil by a man following the planter. The ditch is then dug out to the required depth, the earth being piled in a sloping bank E E above the newly planted quicks, and trodden well down. Hawthorn quicks should be shortened with the pruning shears after planting, leaving about 4 inches above ground. The hedge will require the protection of a paling or wire fence for several years after it is planted. In well-drained or naturally dry soil the ditch and bank may be dispensed with, the ground

being thoroughly trenched for a width of 4 feet along the proposed line, and the quicks lined in after the manner of nursery transplants. If two lines of quicks are planted 1 foot apart, the hedge will the sooner be firmly established; but to plant the rows closer together, or to set the quicks nearer in the rows than 1 foot apart, will defeat the object in view by causing weakly growth.

Two years after planting, the quicks, if they have made good growth, will be ready for a first pruning, and it will then be necessary to decide what contour the hedge is to receive and retain. Undoubtedly the simplest form is the wedge-shape (Fig. 2), but the full-sided hedge is more effective

FIG. 2.—Wedge-shaped Hedge.

FIG. 3.—Full-sided Hedge.

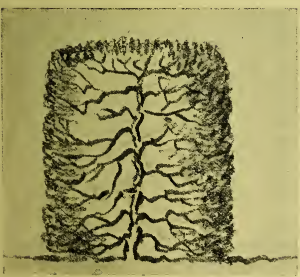


FIG. 4.—Square Hedge.

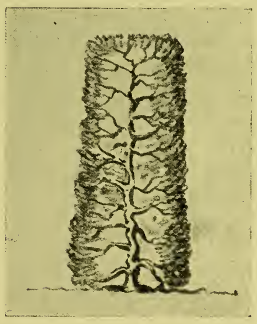


FIG. 5.—Upright or Wall-sided Hedge.

against browsing cattle (Fig. 3); the square (Fig. 4) and upright (Fig. 5) forms being suitable only for gardens and pleasure grounds.

Whatever form may be decided on, it can only be maintained by keeping the ground clean during the early stages of the hedge. It must be hoed twice during the summer, else weeds will choke the underpart of the hedge so as to make it permanently thin. A hedge so treated may be trusted after six years or so to keep down weeds by its own dense shade. The annual pruning, without which no hedge will form an effective fence, should be done, not with shears, but with a sharp switching-knife; and to ensure dense growth, the hedge should not be allowed to grow more than 6 inches

higher and 4 inches broader in each season, until the required height and breadth have been attained. Having reached those dimensions, it should be switched back to the old wood every year. The proper season for switching is from the beginning of November till the end of February. It must be confessed that farm hedges very seldom receive the regular treatment which they require to keep them in order. Roadside hedges may often be seen beautifully kept; but the ordinary farmer, no matter what covenant may be inserted in his lease, cannot be persuaded that a neglected hedge soon becomes no fence at all, and has to be patched up with paling or supplemented with wire. Hawthorn hedges allowed to grow unpruned invariably get bare at the bottom, the lower growths dying off as the plants approach the stature of trees. To restore them to shape, if not too far gone, the plants must be plashed and layered, that is, the strong healthy growths half-cut through, bent over and pegged down to make a fresh start. If too large for this, there is nothing for it but to coppice the hedge, cutting it over and letting it spring afresh from the stools; but of course both these operations render the exclusion of cattle necessary until the new growth has become strong and thick under regular pruning.

Where shelter is the main object in view, beech makes an excellent hedge, but it does not start away so quickly as hawthorn, and must not be pruned until it has begun strong growth, which will not be till the second, or more probably the third, year. Moreover, at no stage of its growth can beech protect itself from browsing cattle, and therefore requires a permanent fence on each side of the hedge.

For ornamental shelter a great variety of species may be used, such as holly, yew, box, many kinds of cypress and thuya, spruce and silver fir among evergreens; hornbeam and cherry plum (*Myrobella*) among deciduous trees, the test of a good hedge plant being its power of responding to hard pruning and clipping by new growth from secondary buds. Most of the true pines are destitute of this power; an attempt to clip such a promising subject as the dwarf *Pinus montana* resulting in the death of the tree.

Many flowering shrubs make ornamental hedges, such as the Ramanas rose (*R. rugosa*), the Japanese quince (*Cydonia japonica*), *Escallonia macrantha*, and *Fuchsia globosa* (the last two only in mild districts), and many others, but severe clipping destroys their beauty of flower. The common barberry should be avoided in agricultural districts, for it is the host of the destructive *Puccinia graminis*, a fungus which requires to pass the first stage of its existence on the leaves of barberry, and the second stage as "rust" upon wheat. The clippings of yew, and possibly of other coniferous trees, develop dangerous poisonous properties, and should never be thrown down where it is possible for cattle to get at them. Many valuable animals have been lost through carelessness or ignorance in this matter.

In mild districts near the sea, no more beautiful hedge can be grown than one formed entirely of the Monterey cypress (*Cupressus macrocarpa*). This tree may be propagated to any extent by cuttings, forms a hedge more rapidly than any other plant, and retains its vivid green colour throughout the year. It should be clipped twice a year, in June and September.

It should never be attempted to make a hedge by mixing plants of different species. Varying rates of growth invariably cause such combinations to prove disappointing.

Hedgerow timber, greatly as it contributes to the beauty of English

scenery, cannot be approved of either by the farmer or the forester. The farmer suffers from shade and drip cast by hedgerow trees upon his crops; the forester knows that clean timber cannot be grown in hedgerows, and that the hedges will not thrive under the shade of trees. *See* also Fences.

Herd Books.—These books are of similar character with the Stud Book, which must be considered as the progenitor of our modern Breed Registers. At first these books took the form of private memoranda of the line of breeding pursued, and later were entrusted to an editor, who received particulars of registration and arranged them systematically. After the Stud Book, the first of these registers was the Shorthorn Herd Book, which has been continuously issued in its present form since 1846. Previous to that date Mr. George Coates had at immense pains collected pedigrees from breeders, and made numerous tours throughout England on horseback with this object in view. His original work, though not entirely free from errors, was accepted as a standard of reference, but in process of time the earlier volumes became out of print. It was to Mr. Henry Strafford, the eminent auctioneer of the breed, that we owe the present Herd Book. He informs us in the advertisement which introduced the first issue in 1846, that the first three volumes of the original work relating to bulls were incorporated in his first volume, and the first three volumes relating to cows were included in another volume, which appeared in 1847. These two volumes, which are respectively entitled "First, second, and third volumes, Bulls," and "First, second, and third volumes, Cows," conjointly with volume iv., Bulls, make up the record of the original book to the close of 1842. Mr. Strafford continued to edit the work until about 1876 when, at his death, it was taken over by the Shorthorn Society at their headquarters, 12 Hanover Square, London; Secretary, Mr. E. J. Powell.

Coates' Herd Book appears annually, and may be taken as a type of all other Herd Books. It has departed little from the original form, except in those necessary abbreviations and references to previous volumes which the size of the work render imperative.

No animal is eligible for entry in the Herd Book unless it has four crosses of pure blood in the case of females, and five in the case of bulls. Entries can only be received on the Society's printed forms, and must be certified by the breeder and owner, and accompanied with fees according to the published scale. For members, 3s. for a bull, and 1s. 6d. for a cow; and for non-members, 10s. for a bull, and 5s. for a cow.

In all Herd Books both bulls and cows are named, and in most of the more modern books both sexes are numbered. In the Shorthorn Herd Book the cows are merely named, and the line of breeding is shown on the female side, the sire of each dam being named with his Herd Book number. The following example, selected from the herd of one of the oldest and most respected members of the Society, Colonel Sir Nigel Kingscote of Kingscote, shows a female registration:—

KINGSCOTE KIRKLEVINGTON 8TH, white, calved April 10, 1899, Vols. 49 and 51, pp. 649, 694. Colonel Sir Nigel Kingscote: sire Beau of Berkeley, 69965, dam Kingscote Kirklevington 4th, by Lord Darlington 43rd, 61155, etc.; see Kingscote Duke 29th, p. 221.

1905, Nov. 6, roan c.c.	Kgsc'te Kirk't'n 13th.	Cowslip Lad 22nd, 85679.	Sir N. Kingscote.

In the case of bulls the entry is made as follows:—

(92144) KINGSCOTE DUKE 29TH.

Roan, calved July 9, 1905. Breeder, Colonel Sir N. Kingscote, Kingscote; sire Cader Idrils, 76279; dam Kingscote Kirklevington 6th, by Florentia's Prince, 62604; g.d. Kingscote Kirklevington 4th, by Lord Darlington 43rd, 61155; gr. g.d. Kingscote Kirklevington 3rd, by Sir Maurice, 56570—Marchioness of Kirklevington 5th by Wild Duke of Rosedale, 47276—Marchioness of Kirklevington 2nd, by Duke of Oxford 20th, 28432, etc. See Auchnacree Kaiser, p. 24.

This entry enables the inquirer to trace the lineage back through the previous volumes on the female side; and the registration number and name of the bull enables him to trace his sire's ancestry on both sides, so that the record is complete. The most recently born calves are given below each cow's record, as produce, in each volume in which her name appears, and these are again entered as adults at a later period. The regular entry of produce under each cow should be made even if the calf dies or is castrated, in order to preserve the record intact.

In working out pedigrees it is necessary to have access to a full set of the Herd Book, as the various references carry the inquirer to the earliest volume. These investigations as to the remotest and collateral ancestry of an animal are very interesting to breeders, and often show close relationships and remarkable cases of interbreeding.

The Shorthorn Herd Book has been selected to illustrate the general system used, as the oldest and most voluminous member of the class.

Before proceeding to notice the other published Herd Books it is necessary to insert a few remarks upon the private records of herds, on which the published records are based.

PRIVATE HERD BOOKS.—Every breeder preserves such private records, and as an example of a convenient form we may take the book supplied by Messrs. John Thornton & Co. as suitable for any breed. The left-hand side of each opening contains rulings for the dam, her name, lineage, colour, and exact age. Opposite these are spaces from left to right for date of service, sire employed, Herd Book number of sire, date of calving, colour of calf, sex of calf, name of calf, and remarks. There is also a reference to Herd Book entries, with space for volume and page. This complete record is used in entering as "produce," and in time the calf, whether bull or cow, can be entered in its own name as a breeding animal. If not, the fate of the animal is recorded as "dead," "castrated," "sold as veal," etc.

The Lincolnshire Red Shorthorn Herd Book.—The Lincoln Reds have long been known as dairy cattle, and have possessed a Herd Book since 1894. The volume for 1907 is the thirteenth of the series. It is bound in red, and red is the colour of every animal described, and assumed to be the colour if not described. Red bulls recorded in Coates' Herd Book are eligible for entry, and their names and numbers are entered in italics. The last ancestress of each recorded female is named characteristically, as Red Rosette, Red Lady, Red Wine, or is described as a "red cow by ——." The thirteenth volume of the Herd Book contains the registers of 265 herds, almost all situated in the county of Lincoln. It contains pedigrees of 442 bulls and a much greater number of cows and heifers. The bulls are numbered but the females are only named, and the general plan of the entries is similar to that followed in Coates' Herd Book. The produce of cows is given below each entry. The book is published by the L. R. S. Association at St. Benedict's Square, Lincoln; Secretary, Mr. William Frankish.

Jersey Cattle Herd Books.—Through the courtesy of Mr. John Thornton the author has been allowed a sight of the first volume of the Jersey Herd Book for 1879. The book is now out of print, and contains a mass of information as to the history of the breed not to be found elsewhere. Mr. Thornton, who edits the English Herd Book of the breed, bestowed an enormous amount of labour in unearthing particulars as to pedigrees. This he did by issuing forms of entry on the plan of Coates' Herd Book, and by this means secured particulars of 275 bulls and 1000 cows. These were printed and placed before the public and Jersey breeders at the Royal Show at Kilburn in 1879. Information as to animals imported from the Island was so difficult to obtain in England that a trusted friend, Mr. Edwin Truelove, was sent by Mr. Thornton, and finally he joined Mr. Truelove himself and remained many weeks on the Island visiting breeders and receiving much assistance from the Jersey Herd Book Committee. It was proposed, and approved by the Committee, to keep back all the cows for a second volume, and that the first volume should consist of five parts—(1) History of the Breed; (2) Pedigrees of Bulls calved before the 1st of January 1879; (3) Record of Prize-winners to the end of 1879; (4) A Reprint of Principal Sales up to the end of 1879; (5) A List of Subscribers, and a voluminous Index. With the history of the breed we have at present nothing to do. It occupies eighty-eight closely written pages, and is of a highly interesting character. Next follow the bulls, beginning with Achievement (1), reserve number at the R. A. S. Show at Manchester in 1879, and ending with Zig-zag (978), with four recorded crosses of pure blood. The third part of the volume begins with the prize-winners and chief exhibits of "Alderney" or Channel Island cattle from 1839 and forwards. It was not till the Wolverhampton meeting in 1871 that Jerseys were named as a distinct class, but no attempt was made (except in the case of Mr. H. J. Le Feuvre's Island entries) to furnish pedigrees. Even Mr. G. Simpson of Wray Park, Reigate, entered his females merely as bred by him. Bulls carried a Herd Book number derived from the Island record, but no attempt was made to supply pedigrees until Mr. Thornton's labours supplied the first elements. These, it must be explained, were obtained at immense pains and were based on Island records, so that there is no doubt of their genuineness.

The sale catalogues from 1865 which are included in this volume are much richer in particulars as to breeding, and must have been of great value to the indefatigable editor. Once started, the way was comparatively simple. It was at Mr. Simpson of Wray Park's sale that Lord Chesham, who presided at the luncheon, May 10, 1878, suggested that the time had arrived when it was advisable to establish a Herd Book for English Jersey cattle, and he asked those who favoured the idea to give in their names to Mr. John Thornton. Such was the beginning of this now most important book.

The English Herd Book of Jersey Cattle is published by the English Jersey Cattle Society at the offices of Messrs. John Thornton & Co., 7 Princes Street, Hanover Square, London, W. Volume xviii., 1906, contains the register of 350 bulls and 1280 cows, and comprises 543 pages bound in red cloth. It is a handsome book, in which the leading awards at shows and the results of the principal sales, together with butter and milk tests, officers and members of the Society, are all recorded. Pages 5–155 are occupied by the births during 1906, and include the fate of the calf. The words "sold to butcher," "died," "premature," "dead," "killed," indicate that all births from registered cows must be recorded in order

to maintain the life-history of each animal, and this is equivalent to the produce entries in other Herd Books following the pedigree of each cow (*see* Shorthorn Herd Book). The bulls occupy eighty-two pages, and are recorded fully with references to the Island Herd Book where necessary. The cows come next, and are entered alphabetically by name, and not by number, and with references to previous volumes where necessary. In many cases the entry is followed by a brief note as to achievements in butter tests or at shows. The results of shows and milking and butter competitions conclude the work. The list of 525 members indicates the wide extent of the breed. In the Summary of Members, p. 543, Sussex leads with 52, Surrey and Hampshire follow with 41 and 42 respectively. Few counties are unrepresented, and the exceptions are the three northern counties of Cumberland, Durham, and Westmoreland, and, rather strangely, Huntingdon.

The Island of Jersey Herd Book.—The Jersey Herd Book, known in this country as the Island Herd Book, is edited by Mr John A. Perree, at 8 Church Street, St. Heliers, Jersey. As is well known, special laws forbid the importation of breeding cattle into the Island, so that purity of descent is insured without the records of back-breeding, necessary where there are many contiguous breeds. The qualification for entry in the Island Herd Book is that no animal is allowed to be entered until it has undergone a public examination by judges. The qualifications are briefly given on the first page of the English Herd Book, and appear to differ slightly in degrees. They are—(1) Pedigree Stock Highly Commended; (2) Pedigree Stock Commended; (3) Foundation Stock Highly Commended; (4) Foundation Stock Commended. These degrees, as they may be called, are represented by capital letters, as, for example, I.H.B. signifies Island Herd Book, P.S.H.C. stands for Pedigree Stock Highly Commended, and it is unnecessary to explain further the letters P.S.C., F.S.H.C., and F.S.C.

The English Guernsey Herd Book for 1907 is the 23rd of the series, and contains the records of 104 bulls and 382 cows. It is edited by Mr. W. C. Young under the English Guernsey Cattle Society, at 12 Hanover Square, London. No animal is eligible that cannot trace back its pedigree on both sides to imported stock, and after March 25, 1885, unless registered in the Herd Book of the Royal Guernsey Agricultural Society. This rule may be relinquished under certain circumstances with the approval of the Council. The book contains rules, by-laws, scale of points, forms of certificates for transfer of ownership, entry, sales and transfers, prizes and awards, and an index, the whole comprising 183 pages neatly bound in cloth.

Herd Book of the Royal Guernsey Agricultural Society, Guernsey, see above.

The Herd Book of Hereford Cattle, vol. xxxviii., 1907, has appeared yearly since 1879. The previous volumes i.–x. were less regularly published, and like most Herd Books the earliest issues were reprints from earlier editions and bound as vol. i., or as in this case vols. i. and ii. In accordance with modern ideas, the Herd Book is published by the Hereford Herd Book Society at their office, 20 East Street, Hereford, and is edited by the Secretary, Mr. W. G. C. Britten, of the same address. The book is illustrated by photographic representations of a few of the most noted animals of the year. All the animals recorded are red with white faces except when otherwise described, and hence colour seldom appears in the records. The bulls are numbered and named, but cows are only named. The volume for 1907 contains an alphabetical record of 801 bulls, each accompanied with day and date of birth, name of breeder and owner, and a full pedigree with references to the records of each dam.

The second division contains cows and their produce for the year, or previous years, on the same principle as already described under Shorthorn Herd Book.

The Appendix contains a list of principal prize-winners, and there is also a schedule of exportation certificates and of prices given for Hereford cattle at the leading sales. The Index to Breeders includes about 331 names, almost all being residents in the counties of Hereford, Monmouth, Worcestershire, Shropshire, Warwickshire, and Wales. There are several herds established in Ireland, and in Buenos Ayres. The contributors therefore are mostly found in the south-western Midlands of England.

Davy's Devon Herd Book.—Through the courtesy of Mr. John Risdon both the first and the last volumes of this book are before us. The first volume is interesting as embodying the labours of Lieut.-Colonel John Tanner Davy, who at enormous labour and great cost collected the materials necessary. For more than thirty years the work was carried on by him at his own risk and expense, during which time eight volumes appeared. In 1883 the copyright was disposed of to Messrs. Hawkes and Risdon, who shortly afterwards transferred their interests in the work to the Devon Cattle Breeders Society. The first volume opens with a memoir of the late Colonel Davy, and is continued with a list of bulls and cows. The last volume, issued in 1907, is the 30th of the series, and comprises 380 pages. It is chiefly composed of records of bulls and cows. Both sexes are numbered, and those of the females follow the names as regularly as those of the bulls. This is useful to readers, as unless numbered the hunting up of females entails a good deal of trouble. The descent of pure-bred Devon cattle goes back far anterior to any records of breeding, and in the first volume many of the animals are traced back to the early breeders, such as Messrs. Quartly, Davy of Flitton, Merson, G. Turner, Parsons, Bernal, and Snow. Some of the animals calved in 1840 and even in 1838 boasted several crosses of recorded pure blood. The births are entered separately, and not as produce under each cow. The entries are all of young animals born or entered since the last issue, and are therefore only entered once for all. This saves the re-entries necessary in Coates' Herd Book, where in order to enter produce it is necessary to re-enter the cow a second or third time.

The Herd Book of South Devon Cattle has reached its 10th vol. (1907), and is published by the South Devon Herd Book Society at its head-quarters, Gate House, Totnes, Devon; Secretary, Mr. Alfred Michelmore. The volume contains no rules or records of sales and shows, but is occupied by the names and addresses of subscribers and contributors, and lists of young bulls and heifers with pedigrees. The females as well as the males carry numbers. The volume is divided into Herd Book and Supplement, the latter occupying 217 out of a total of 250 pages. The Herd Book numbers are relied upon without special reference to previous volumes. The contributors number 180, and are principally confined to South Devon.

The Sussex Herd Book is edited under the Council by Mr. W. C. Young, 12 Hanover Square, London, and the 22nd volume appeared in 1907. No animal is eligible for insertion unless its sire and dam are recorded, and particulars of all calves must be given under the head of "Produce," with name, or if dead, or steered. All entries must be made on the Society's printed forms. The scale of charges is for bulls with number, 10s. 6d.; for bull as produce, 2s. 6d.; for cow with one calf as produce, 2s. 6d. For non-members the entry fees are doubled. Both bulls and cows are numbered,

and in entering produce the same system is used as in the Shorthorn Herd Book, already described. The volume for 1907 contains entries of 95 bulls and 549 cows, and consists of 221 pages, neatly bound in cloth. Like the Shorthorn Herd Book, the first volume was compiled from various records, and subsequent volumes by direct entry.

The Red Polled Herd Book.—The volume for 1907 is the 24th of the series. It is published at the *Mercury* Office, Norwich; Secretary, Mr. Albert D. Euren. The cattle are arranged alphabetically in tribes, and comprise Old Norfolk and Old Suffolk stocks. The book opens with a list of herds and owners, 76 in all, which is followed by the Register of Bulls 9655–9759 and of cows 20623–21007. There are also a standard description of the breed, a table of milk yields from various herds, a list of transfers, and prizes won during 1906. The system adopted appears to be, entry shortly after birth and generally within the previous year to publication, and numbering of both bulls and females. This renders reference to previous volumes easy, as the number is sufficient guide. There is no Index, as the system of numbering each animal renders it unnecessary.

The Ayrshire Herd Book. Vol. xxx., 1907.—This voluminous work is published at the Ayrshire Cattle Society's offices, 58 Alloway Street, Ayr; Mr. John Howie, solicitor, Secretary and Editor. The most recent volume contains the names and pedigrees of 1638 cows and 462 bulls, both sexes being numbered. This is an excellent plan, as it enables the pedigree hunter to at once refer to the ancestry of a cow, and renders repetition unnecessary. The immediate sire and dam of an animal with Herd Book numbers attached are only given, with colour, date of calving, and breeder's name. The Appendix contains a list of cows and heifers without numbers, approved of by the Committee, but not tracing directly through both dam and sire to previous volumes. Such cattle are not eligible for entry among the registered cattle, but when admitted on the appendix their produce may be entered. The book also contains scales of points applicable to both sexes, and a prize list. It is a business-like record, containing two typical pictures of cows, and contains 846 pages handsomely bound in cloth.

The Highland Herd Book is published at the office of the Breed Society, 15 High Street, Inverness; Secretary, Mr. Duncan Shaw, W.S. No animal can be entered up to the present time unless its sire or dam or its grandsire or grandam on either side has already been entered in the Herd Book, and all its other ancestors were of pure Highland breed. The Editing Committee are empowered to make exceptions if they are satisfied with the animal's antecedents, on payment of double fees. Such were the restrictions up to the issue of volume x., 1900, now before us, and are only likely to be altered in favour of entry in a Herd Book record.

The Polled Herd Book of Aberdeen-Angus Cattle is published at 9 Old Market Place, Banff, N.B.; Dr. Alexander Ramsay, Secretary and Editor. An account of the origin and history of this book is given in the article on Aberdeen-Angus Cattle, vol. i. of this Encyclopædia. The book now before us is the 29th of the series, and bears date 1904. It is a bulky volume of 500 pages, and both bulls and females carry Herd Book numbers. The entries contain all breeders of Aberdeen-Angus cattle, whether residing in England, Ireland, or Scotland. There is also an English Aberdeen-Angus Association, of which Mr. Albert Pulling, Beddington, near Croydon, is Secretary.

The Galloway Herd Book. Vol. xxvii., 1907.—This book is published by

the Galloway Cattle Society, and is edited by the Very Rev. John Gillespie, LL.D., Mouswald Manse, Ruthwell, R.S.O. The most recent volume contains the records of 254 bulls and 377 cows and heifers, all of which are numbered. Animals whose sires and dams are entered in the previous volumes are eligible, with the exception of any which have developed "scurs," *i.e.* short, malformed rudimentary horns. The volume is neatly bound in black cloth, and comprises a Prize Record for 1905–06, List of Breeders and Owners, and an Index, but the pages are not numbered. The entries all refer to animals born during the year 1905 and 1906 with their pedigrees given in full, without reference to previous volumes, except the Herd Book numbers. This enables the reader to see at a glance the pedigree without further reference, but it occupies space. Many of the entries show ten to twelve crosses of registered sires and dams, and three for females and four for bulls appear to be the minimum.

English Kerry and Dexter Herd Book.—This book appears annually, and was founded in 1892 and incorporated in 1899. The volume for 1907 is the eighth of the series, and contains the records of 12 bulls and 90 cows and heifers of the Kerry breed, and of 30 bulls and 118 females of the Dexter breed. Entry is allowed after inspection by a committee of skilled breeders, and inspections are held from January 1 to September 30, after a fortnight's notice from members. Eligible animals are entered for a fee of 3s. 6d., and animals entered after inspection at 5s. each. Non-members pay double fees. Tattooing on the ear is the method employed for marking, the die or instrument being kept in the custody of the Secretary, Mr. F. A. Hordern, 12 Hanover Square, London, W. All animals entered in the Royal Dublin Society's Herd Book are eligible for entry in the English book on payment of the usual fees. A cross between the Kerry and Dexter is considered as a half-breed and cannot be entered. The book contains standard descriptions of both Kerry and Dexter with scales of points. The Kerry is described as black and the Dexter as black or red.

Royal Dublin Society's Herd Book of Kerry and Dexter Cattle, see above.

The Welsh Black Cattle Herd Book.—The first volume of this book appeared in 1905, and was compiled and arranged by the committee of the Black Cattle Society. The Secretaries and Editors are Messrs. James Thomas and Son, 9 Victoria Place, Haverfordwest. The first volume contains the registers of 211 bulls and 698 females, and both sexes carry Herd Book numbers. Although a joint Herd Book was only issued at the above date, the first Herd Book of Welsh Black Cattle appeared in 1874 under the auspices of Mr. James B. Bowen of Llwygwair, Pembrokeshire. Unfortunately the North Wales breeders agreed to publish a separate book, under the name of the North Wales Herd Book. "The first joint volume is the welcome outcome of many negotiations and conferences on the subject." The second volume appeared in 1907. The pedigrees in many cases carry references to both the original works indicated by the letters S.W. and N.W. attached to the regulation numbers.

Herdwick Sheep.—This hardy breed is identified with the Lake district of Cumberland and Westmoreland, and occupies an important position in the pastoral life of its picturesque mountains and dales. Although restricted in its geographical limits, it claims to be of pure extraction. Tradition indicates that it was first introduced through shipwreck, but whether from Spanish galleons scattered by Drake and Hawkins, and dashed to pieces upon the inhospitable shores of the north-west, or from

a ship stranded on the Cumberland coast early in the eighteenth century, will probably ever remain doubtful. Both traditions are preserved. The circumstantial story of the forty sheep which swam ashore from the wreckage of a Spanish galleon in 1588, and landed, by their own efforts, on the sandy shore at Drigg, Cumberland, bears a certain impress of authenticity. It is also stated that they were then and there claimed as flotsam and jetsam by the lord of the manor.

The rival tradition as to the unknown ship stranded "early in the last century" on the Cumberland coast, is less interesting, and perhaps less probable when the antiquity of the race is considered. Mr. James Bowstead, cousin of the late Sir Jacob Wilson, was an enthusiastic breeder of Herdwicks, and wrote (*circa* 1890) an able article on the breed for the *Live Stock Journal Almanack*. In it he says, "There are many yeomen in the dales of Cumberland and Westmoreland, whose flocks have been handed down from father to son for generations, without a blot or stain on their pedigrees, and he would be a degenerate son who would dare to try a cross." This seems to point to an earlier establishment of the breed than the eighteenth century, and somewhat discredits the tamer story of an unhistorical wreck of uncertain date. The writer, therefore, leans to the more interesting episode of the Armada, as more consistent with a tradition preserved among a race of hereditary farmers of exceptional vigour. One of this hardy race himself remarked to the writer, "Cumberland men are boys at eighty," and with such men a tradition of little over a century old would scarcely deserve the name.

Whatever the origin of Herdwick sheep, they are distinct from the Blackfaced, the Lonk, or the Limestone (Crag) breeds of Scotland and Lancashire. If not the result of crossing, a proposition which is stoutly denied, they must have been either indigenous or imported, and the latter appears to be most probable. They possess characters and instincts peculiar to themselves. For example, the lambs are born with perfectly black heads and shanks, with the exception of a little white on the tips of the ears. These white hairs gradually increase, so that at six months old one-third or half of the ear will be hoar-frosted (rimy), and there will be distinct bands of white round the feet, shading off to the black of the legs; and by this time also about an inch of the muzzle will have become frosted too. This change of colour goes on until some, at the age of three years old, are perfectly white, whilst others remain a sort of steel grey. There is no other race of British sheep which exhibits a similar peculiarity. Mr. Bowstead thus describes a mature Herdwick sheep: "A heavy fleece of fairly fine wool disposed to be hairy on the top of the shoulder, growing well down to the knees and hocks; poll and belly well covered; a broad bushy tail, and a well-defined topping; head broad; nose arched or Roman; nostrils and mouth wide; teeth broad and short; jaws deep, showing strength of constitution and determination; eye prominent and lively, and in the male defiant; ears white, fine, erect, and always moving, as has been said, 'like a butterfly's wing.' There should be no spots or speckles nor any token of brown on the face, as these are considered sure tokens of a cross. Horns in the ram are desirable, but not essential. They should rise out well at the back of the head, be smooth and well curled. White hoofs are much preferred. The females are polled."

An interesting and appreciative account of Herdwick sheep, by Mr. Rowlandson, appeared in the *Journal* of the Royal Agricultural Society for 1849.

The origin of these sheep has already been discussed, but it may be

Parsons.

HERDWICK RAM.

mentioned that Mr. Rowlandson quotes the tradition as to the shipwreck on the Cumberland coast early in the eighteenth century, and also points out the similarity between Herdwick sheep and some of the Welsh breeds. He states that they possess a peculiar sagacity in foreseeing the approach of a snowstorm, and are seen to cluster together on the most exposed side of the mountain, where the violence of the wind prevents the snow from lying. This instinct caused them to be regarded with a degree of interest amounting to superstition. Their excellent qualities and adaptation to their new situation became speedily evident. An association was formed, one of the regulations of which was that no member should sell a ram and not more than five ewes in one season. Great difficulty was experienced in maintaining purity of blood on account of the impossibility of keeping these active animals within bounds. As they are always depastured on the open mountains where blackfaced sheep also graze, it was almost impossible to prevent crossing. This was, however, considered highly disadvantageous, and an annual show was established for encouraging the breeding of pure Herdwicks, entitled The Cumberland Fell Dales Association Sheep Show. Even as early as 1848 premiums for Herdwick sheep were awarded to no fewer than ninety-four competitors from the following Wards:—

The Ward of Allerdale-above-Derwent.
The Ward of Allerdale-below-Derwent.
Premiums offered by the Keswick manufacturers for the best white-fleeced sheep of the genuine Herdwick breed, bred and depastured in the Ward of Allerdale-above-Derwent.

The Herdwicks were at that time described as polled, but, more properly, the ewes are polled and the rams polled or horned as the case may be. As already stated, a white or steely-grey face is the sign of true breeding. An interval of sixty years has produced improvement, as already seen, in the description given by Mr. Bowstead. It is also stated that Herdwick sheep are peculiar for having fourteen ribs on either side instead of thirteen, which, if true, is very remarkable.

The greatest care is taken in breeding, and good ewes are kept in the flock until they are ten or fifteen years old, and some are said to have attained the age of twenty years (Rowlandson). The wethers go off at the age of four and a half to five and a half years old, and are generally killed without being placed upon better pasture, being found sufficiently fat off the mountains. It is even stated that they do not thrive on turnips, clover, and other artificial foods, and that attempts made in the direction of artificial feeding have resulted in deterioration in the weight of the sheep, and the consequent loss of the crops and food used in the process. It is, however, more likely that sheep, habituated to freedom and natural herbage on the mountains, resent confinement, and show a repugnance to turnips and trough food. This repugnance is not confined to Herdwick sheep, but is noticeable in other cases of a similar kind; and it is hard to believe that Herdwick sheep could not be brought up to enjoy artificial foods and cultivated crops like other breeds. When fat such wethers weigh from 10 to 12 lb. per quarter, and are alleged to be the finest mutton in England, assimilating in flavour close to venison; they also, when at the fattest, possess a larger proportion of lean meat than any other sheep. No hay is given to Herdwicks during the winter; they support themselves in the deepest snow by scratching down to the herbage, and if any part is blown bare they are sure to find it. The lambs are dropped about the 12th of May, and are well covered with wool when born. They are sometimes taken to the lower grounds the

first winter. Ewes are not put to the ram until they are two and a half or three and a half years old.

There is a striking peculiarity in connection with Herdwick sheep, namely, that when once accustomed to a particular portion of mountain land, they do not wander like the blackfaced sheep. So attached do they become to their locality, that ewes even when removed to a distance will instinctively return to their former neighbourhood and location, at the lambing season. This disposition to return to their native haunts has often been a serious difficulty in establishing a flock of ewes, and can only be met by purchasing ewe lambs. The same instinct is observable among Welsh sheep, and seems to point to a common origin.

Such are a few facts and statements which have been published with reference to Herdwick sheep. Some of them appear somewhat apocryphal, while others have no doubt been modified by time. They embody the results of inquiries and observations made in 1848, and we turn to more modern sources in order to obtain a just idea of the breed as it exists to-day.

They are a hardy race of mountain sheep, finding subsistence upon the high lands of Skiddaw, Wasdale, Langdale Pikes, Eskdale, Ulpha, Coniston, and Seathwaite, or grazing upon the grassy slopes and dales of Grasmere, Ambleside, Kendal, and Windermere. At the close of each season wethers are disposed of at the fairs held at Cockermouth, Penrith, and Kendal. Their home is on the mountain side, and the management is simple in character and greatly aided by the independent character of the animals.

The Herdwicks are awarded classes at the Royal Agricultural and other shows, and are best represented when these meetings take place at Manchester, Newcastle, and other northern centres. At Park Royal they were represented by exhibits from the flocks of Mr. William Mackereth, Green Bank Farm, Ambleside; Mr. John R. Watson of South Mosses, Cockermouth; Mr. William Leathes of Wern Fawr, Ruthin (Wales); and Mr. John Robson of Newton, Bellingham, Northumberland.

Heredity and the Principles of Breeding.—We speak of a son or heir inheriting the worldly possessions of his father, and we also speak of a son inheriting the physical and mental traits or characters of his father. The worldly possessions in passing from father to son undergo no change, but the physical and mental traits of the father are never transmitted unaltered to his offspring. It is doubtless in a sense true that like begets like, that, *e.g.*, the offspring of sheep are sheep, not goats or antelopes, but in no case are the offspring the exact image of either the sire or dam, or an exact blend of their immediate parents. In some cases they reproduce the more striking points of a remote ancestor, in other cases they appear to possess points new to the race or strain to which the offspring happen to belong. The branch of biology which deals with the likenesses and differences between parents and their offspring, which explains as far as possible why in some cases the offspring are a blend of the immediate parents or almost the image of one of them, why in other cases they resemble a more or less remote ancestor, and why they sometimes present entirely new traits—which deals with the transmission of acquired characters to the offspring—is known as heredity—from *heres heredis,* an heir.

When it was believed that all the species of plants and animals had remained unaltered from their first appearance on the scene, the study of heredity was comparatively simple, but now that the fixity of species

doctrine has given place to the doctrine of descent with modifications, the study of heredity implies a study of variation in a backward as well as in a forward direction, *i.e.* of Reversion as well as Evolution or progressive development.

Half a century ago it was assumed that, as the word heredity suggests, the inheritance of the characters of the parents was in a sense comparable to the inheritance of the possessions of the parents, that the parents could transmit traits acquired during the lifetime as well as traits inherited from their ancestors, and traits which resulted from the blending of the germ plasm out of which they were developed. Darwin, *e.g.*, believed that the germ cells which give rise to new individuals consist to some extent of invisible particles (to which he gave the name gemmules), which are constantly streaming from all parts of the body to the reproductive glands. By means of these gemmules it was assumed each germ cell faithfully represented all the different parts of the body (or soma) at the time it was produced. Hence according to Darwin the germ cells of one period differ from those of another and, more important still, they are able to transmit to the offspring mental and physical traits acquired by the parents during their lifetime, *i.e.* to hand on to the offspring not only congenital or inherited characters, but also characters acquired by use or disuse or from changes in the surroundings.

Now, however, partly as the result of investigations as to the origin of the germ cells, and partly as the result of experiments, it is believed the parent is incapable of in any way altering the composition of the germ cells. The germ cells may vary with the age of the individual in which they are stored, and may be influenced by changes in the food, temperature, etc., but they seem incapable of being so modified that they can transmit either physical or mental changes—*e.g.*, mutilations or changes resulting from accidents or disease or from use or disuse—acquired during the lifetime of the individual to which they happen to belong.

According to the now commonly accepted view, the germ plasm (*i.e.* the eggs and sperms) may be regarded as an inheritance, as consisting of protoplasm specially reserved for the purpose, protoplasm similar to that which formed the body or soma in which they lie, but which took no part in forming the body, and beyond shelter and nourishment received nothing from the body.

The ticks associated with Texas fever in cattle may be developed from eggs infected with the minute organism (*Piroplasma*) which is the cause of Texas fever. In a like manner the embryos contain from the outset the cells which eventually give rise to eggs and sperms—hence the germ cells may be regarded more as parasites than products of the individuals in which they find a habitat.

As in studying heredity one is more concerned with the germ cells than with the adults which nurture them, it is necessary to learn something of their structure, history, and maturation, and of what happens during fertilization.

A large number of plants and animals are unicellular, consist from first to last of a single cell, and are hence comparable to one of the colourless corpuscles of the human blood, but the majority of plants and animals consist of a countless number of cells specialised for different kinds of work. In most of the multicellular organisms, there are, as already indicated, a number of germ cells which take no part in forming the organs and tissues of the body or soma, but, as maturity is reached, give rise to ova or sperms.

The male germ cells or sperms are exceedingly minute, but the eggs, though often microscopic, as, *e.g.*, in mammals, are sometimes so laden with food for the nourishment of the embryo that they reach a considerable size. This is especially the case in birds and reptiles. But whether a germ cell is large or small, it has always at the outset the same structure, consists of a minute piece of protoplasm, near the centre of which lies what is known as the nucleus. The ovum represented in Fig. 1 consists of a capsule (cell membrane), of protoplasm (cytoplasm), and of a nucleus. The sperm represented in Fig. 2 also consists of a nucleus and protoplasm, but the protoplasm, small in amount, is drawn out to form a long motile process or flagellum. In both ova and sperms the nucleus consists partly of easily stained protoplasm, and partly of protoplasm which has little or no affinity for staining re-agents. At times, the easily stained protoplasm of the nucleus appears in the form of rods or chromosomes. The number of nuclear rods is the same in all the cells of each species; in some species the nuclear rods are few, in others they are numerous. As the breeding season

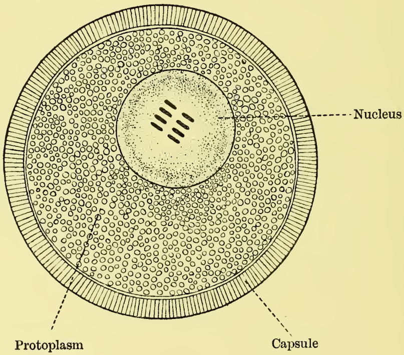


Fig. 1.

Fig. 2.

approaches, remarkable changes take place in the germ cells. In the case of the male, each germ cell eventually divides into two cells, each of which has the normal number of nuclear rods. Each of these complete germ cells again divides, but the cells produced by this final division have only half the normal number of nuclear rods or chromosomes. If the normal number of these rods or chromosomes is eight, each of the cells resulting from the last division only contains four chromosomes. The rods having been reduced by one-half, the male germ cell, as a rule, develops a tail or flagellum (Fig. 2), and thus reaches maturity; the flagellum enables the ripe sperm to wriggle about, and thus increases its chances of meeting with an ovum.

In the case of the female germ cell, as maturity is reached the nucleus divides to form two nuclei, each of which has the normal number of chromosomes. One of these nuclei migrates to the surface, and usually settles down between the cytoplasm and the cell membrane.[1] The nucleus

[1] Though the migrating nucleus (known as the first polar body) may divide into two, it never takes any part in forming a new individual.

which remains in the cytoplasm again divides, but the two nuclei which result from the second division have only half the normal number of chromosomes. One of the nuclei with half the number of chromosomes persists (Fig. 3, ♀), the other (Fig. 3, 2 *p b*) migrates to the surface (thus forming a second polar body), and eventually disintegrates.

When the female germ cell has by a series of complex changes acquired

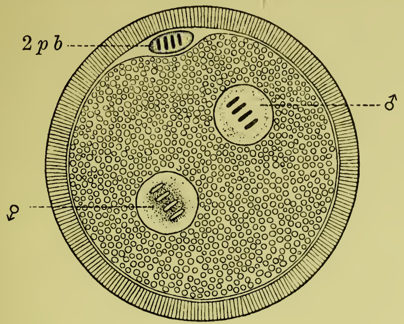


Fig. 3.

a nucleus containing half the normal number of chromosomes (*i.e.* what is known as the female pro-nucleus) its maturation or process of ripening is complete. In the vast majority of cases, the ripe ovum (*i.e.* an ovum in which the number of chromosomes has been reduced) is unable to make any progress towards forming a new individual until it has obtained from without as many chromosomes as it has lost. Unless the normal number

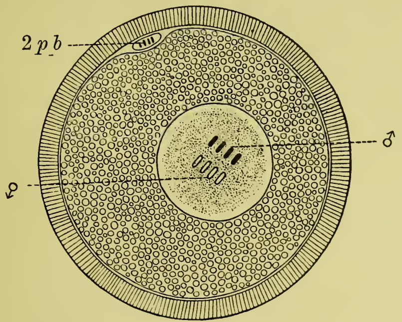


Fig. 4.

of chromosomes is restored within a given time, the ripe ovum disintegrates and disappears. If, however, before degeneration sets in, a sperm, carrying the requisite number of chromosomes and probably some cytoplasm, succeeds in penetrating the cell wall and forming in the cytoplasm of the ovum what is termed the male pro-nucleus (Fig. 3, ♂), the first phase in the act of the fertilization of the egg is accomplished. When later the male pro-nucleus more or less completely blends with the female pro-nucleus (and

thus restores as many chromosomes as were lost during the reduction of the egg nucleus), the act of fertilization is completed (Fig. 4). Given favourable conditions, the fertilized egg, then, by continuous division gives rise to a countless number of cells, some of which are reserved to form the germ cells of the new individual, while the majority are utilised to form the organs and tissues (the soma) of a new individual, which, as it develops, recapitulates in an imperfect way the ancestral history of the species to which it belongs, and eventually presents the more striking traits of one of its parents (sometimes the male, sometimes the female), is a more or less perfect blend of its parents, reproduces the characters of a more or less remote ancestor, or by progressive variation in one or more points advances beyond all the other members of its race.

When the development of, say, a mammal is studied, it becomes evident that the more striking characters of the remote as well as of the more recent ancestors are represented in all fertilized eggs and that in some cases the characters of one of the immediate ancestors (*i.e.* one of the parents) are so fully represented that all the mental and physical traits are, or appear to be, faithfully transmitted to the offspring. In the case of the higher animals the possibilities are, as a rule, so great that it is impossible to predict what will be the exact characteristics of the individual developed out of any given fertilized egg. The new individual may at birth present one or more traits which characterised a very remote ancestor, *i.e.* an organ which has long been vestigial may be redeveloped (*e.g.* one of the digits present in the three-toed ancestors of the horse), or the development may be arrested at the stage reached a century ago (in, *e.g.*, trotting horses or in breeds of fowls, dogs, or cattle), or it may be carried appreciably further than it ever was before, and thus give rise to a new variety. With the origin and transmission of new characters (progressive variation) the breeder is especially concerned when he is endeavouring to produce a new variety or breed, but when a strain has once been established his chief object is to, if possible, prevent any arrest in the development, *i.e.* to prevent regression to mediocrity and still more reversion to remote unimproved ancestors.

Reversion.—Why vestigial structures are sometimes redeveloped it is impossible to say, and we are still unable to account for progressive variation, but we, I think rightly, associate reversion to comparatively recent ancestors with sexual or bi-parental reproduction. When cultivated plants are grown from seed, marked reversion to wild and unimproved types is common, but in plants grown from cuttings reversion may be completely absent. When animals are produced from unfertilized (parthenogenetic) eggs — from a single parent—evidence of reversion is small or altogether absent. Even when animals are the offspring of closely related members of a strain formed by long-continued in-and-in breeding (*i.e.* from fertilized eggs that differ but little from parthenogenetic eggs) reversion is reduced to a minimum. On the other hand, when the parents belong to remotely related strains or to different species, the development is often arrested, with the result that the offspring resemble in not a few of their characters comparatively remote ancestors.

All the improved breeds have hitherto been formed by more or less close in-and-in breeding. In-breeding apparently sooner or later leads to loss in size, vigour, and fertility. Hence one of the chief problems breeders have to face is how to maintain the size, vitality, and fertility of their improved strains. Hitherto when flocks and herds have shown signs of deterioration intercrossing has been resorted to, *i.e.* cross-fertilization,

which by in-breeding has been practically in abeyance, is allowed for a time a free hand.

That breeders are right in resorting to intercrossing when signs of decadence appear in their flocks and herds, is strongly supported by the behaviour of simple unicellular organisms belonging to the great Protozoa group, which includes the now familiar micro-organisms associated with malaria, sleeping-sickness, and Texas fever. When a Protozoon (*e.g.* the infusorian *Stylonichia*) is isolated and is kept under observation, it multiplies by fission, *i.e.* the entire creature divides to form two individuals, the one the image of the other; each of these then divides, and the process of fission continues until a large colony is produced. But eventually a time comes when the new individuals produced are small in size, have imperfect nuclei, are incapable of moving freely, and generally show marked evidence of degeneration. If minute doses of beef-tea or alcohol are given in time, the degeneration may be staved off for a period, but unless cross-fertilization is resorted to, the whole colony (which may consist of over three hundred individuals) eventually dies from senility. If before the nucleus begins to degenerate, individuals belonging to another colony are introduced, conjugation at once takes place between the members of the two broods, protoplasm passes from the one to the other, and as the result of what virtually amounts to cross-fertilization, the all but exhausted members of the first colony obtain a new lease of life—are rejuvenated—and again begin to multiply by fission. That in the case of unicellular Infusoria, the timely exchange of protoplasm by two individuals (even if they are both approaching senility) restores loss of size, vigour, and fertility, has been clearly demonstrated. That cross-fertilization in multicellular organisms produces the same results is suggested, if not absolutely proved, by a countless numbers of experiments.

It is, however, well to bear in mind that some invertebrates continue to flourish without, except at long intervals, taking advantage of cross-fertilization. In the case, *e.g.*, of the crustacean *Cypris*, innumerable generations are produced from eggs which develop without being fertilized; in others, *e.g.* in plant lice (*Aphides*), a generation produced from unfertilized (parthenogenetic) ova alternates with a generation developed from eggs fertilized in the usual way. It is also well to bear in mind that amongst higher forms some species suffer less than others from close in-and-in breeding. While cross-fertilization seems to have for one of its objects the maintenance of size, vigour, and fertility, it certainly, as already stated, often results in reversion, in an arrest in the development, which restores, if not an ancestral type, at least ancestral traits. Every breeder can recall instances of reversion to more or less remote ancestors, and most breeders believe that there is an intimate relation between the amount of the reversion and the differences between the parents. As Darwin states, "Reversion is not a rare event depending on some unusual or favourable combination of circumstances, but occurs so regularly with crossed animals and plants, and so frequently with uncrossed breeds, that it is evidently an essential part of the principles of inheritance."

Perhaps it ought to be mentioned that evidence of reversion is far more frequently met with in animals and plants living under domestication than in wild animals and uncultivated plants. This is doubtless due to the fact that wild species have been slowly evolved, each adapted for its own environment, while domestic animals and cultivated plants having in many cases been produced rapidly, are often unstable and more liable to undergo both regressive and progressive changes.

A few examples of reversion may be given—

"A pointer bitch produced seven puppies; four were marked with blue and white, which is so unusual a colour with pointers, that she was thought to have played false with one of the grey hounds, and the whole litter was condemned, but the gamekeeper was permitted to save one as a curiosity."[1] It was eventually proved that the young pointer had reverted to (and was the image of) his great-great-grandam, a blue and white pointer of pure descent.

Some years ago I crossed a yellow collie, bred by Colonel Malcolm, C.B., with a well-bred Dalmatian. The pups neither resembled young collies nor young Dalmatians, but rather suggested young pointers or fox-hounds. The ground colour was nearly white, two had large dark brown blotches, one had four lemon-coloured patches. This was apparently an instance of reversion towards the mediæval ancestors of the Dalmatian.

Six weeks old horse embryos have three complete toes on both the fore and hind limbs. Of these the middle one is larger though not more perfect than the second and fourth. In having three toes a young horse embryo resembles the horses which flourished at the end of the Miocene period. Sometimes Shire mares have foals with one or more extra digits, and I have heard of a thoroughbred colt with an extra digit. Extra digits in horses are sometimes due to a splitting of the normal (third) toes—as an extra thumb on man or two heads on a sheep result from splitting or dichotomy—but in horses the extra digits are in some cases due to the reappearance of digits which normally existed in ancestors which lived before the Great Ice Age, *i.e.* many thousands of years ago.

The reappearance of extra digits in Shires, Clydesdales, and thoroughbreds is not the result of intercrossing.

Intercrossing horses and zebras has not hitherto led to any marked changes in the skeleton, but it has led to what appears to be pronounced reversion in the markings. In 1899 I mentioned that some of my "hybrids in make and disposition strongly suggest their zebra sire, others their respective dams; but even the most zebra-like in form are utterly unlike their sire in their markings. It is not a matter of taking after a grandparent, but after an ancestor thousands of generations removed, an ancestor probably far more like the Somali than any of the Burchell zebras . . . even when the hybrids are distinctly horse-like they never repeat recently acquired peculiarities, such as a blaze or short ears, high withers, or a small head and a long neck."[2]

Professor Jaeger has recorded a good case of reversion with pigs. "He crossed the Japanese or masked breed with the common German breed, and the offspring were intermediate in character. He then recrossed one of these mongrels with the pure Japanese, and in the litter thus produced one of the young resembled in all its characters the wild pig; it had a long snout and upright ears, and was striped on the back. It should be borne in mind that the young of the Japanese breed are not striped, and that they have a short muzzle and ears remarkably dependent."[3]

"There is reason to believe that sheep in their early domesticated conditions were brown or dingy black, but even in the time of David, certain flocks were spoken of as white as snow. During the classical period the sheep of Spain are described by ancient authors as being black, red, or tawny. . . . The Rev. W. D. Fox was informed that seven white Southdown ewes were put to a so-called Spanish ram which had two small black spots

[1] Darwin, *Animals and Plants*, vol. ii. p. 8. [2] *The Penicuik Experiments*, p. xii.
[3] Darwin, *Animals and Plants*, vol. ii. pp. 17, 18.

on his sides, and they produced thirteen lambs, all perfectly black. Mr. Fox believes that this ram belonged to a breed which he has himself kept, and which is always spotted with black and white; and he finds that Leicester sheep crossed by rams of this breed always produce black lambs; and he has gone on recrossing these sheep with pure white Leicesters during three generations, but always with the same result."[1] The breeder, it may be added, from whom the spotted ram was obtained had gone on for six or seven generations crossing with white sheep, but still black lambs were invariably produced.

"I crossed a prepotent white fantail cock having thirty feathers in its tail, with a cross between an 'owl' and an 'archangel' pigeon, and obtained a pair of birds almost identical in make and colour with a pair of wild blue rock pigeons from the Outer Hebrides. The wings were barred, the croup white, and the tail consisted of twelve feathers each with a black bar near the tip."[2]

From these cases it is evident that reversion is sometimes more than arrested development. In the extra digits which occasionally appear in Shires we have an imperfect restoration of a complex structure which even in Pliocene times was in a vestigial condition—a redevelopment in fact of an ancient "rudimentary" organ.

If reversion instead of being rare is constantly occurring in both plants and animals, it has doubtless played an important part in evolution. Had the tendency to revert been disadvantageous, it would certainly have been eliminated by natural selection.

In the case of wild forms it will probably be found reversion is limited when the distribution is limited in extent and the conditions are uniform and stable, more pronounced when the area of distribution is wide and diversified and the conditions variable. Reversion by now and again reproducing old types has probably been of great use to species in areas in which there has been an alternation of very different conditions. In some areas the climate has been cold and dry at one period, cold and moist at another, or warm and dry periods have alternated with warm and moist periods. During glacial and interglacial periods species able to reproduce by reversion forms adapted for steppe conditions at one time and subtropical conditions at another, would have the advantage over species so fixed and stereotyped that they were incapable of reproducing by reversion ancestral types adapted for a cold climate at one time and a warm genial climate at another.

In the case of domestic animals the varieties descended from wild ancestors, which managed to survive notwithstanding profound changes in their environment, are more capable of adapting themselves to different climates than varieties descended from ancestors accustomed for untold ages either to favourable conditions within the tropics or to trying conditions within the Arctic circles.

Another possible use of reversion has doubtless been giving species which, by excessive variation, ceased to be adapted for their environment, a chance of getting rid of new and dangerous characteristics. In other words, reversion serves as a check on excessive variation. Amongst wild as amongst tame forms, sporting or discontinuous variation doubtless now and again takes place. In wild as in tame animals the sports may be of the nature of monsters, and never have a chance of leaving descendants; but sometimes the new variation may only require some slight modification to prove highly beneficial.

[1] Darwin, *Animals and Plants*, vol. ii. pp. 3 and 4. [2] *The Penicuik Experiments*, p. xxvi.

According to Galton's law of ancestral heredity the toning down of the new characters would under ordinary conditions be rapidly effected by means of reversion, for if this law holds, the two parents on an average only contribute one-half of the characters of their offspring, the other half being inherited from their less immediate ancestors.

Breeders, it need hardly be said, sometimes find reversion highly beneficial. When a new and desirable variation appears, an effort is at once made to fix it by in-and-in breeding. In some cases close interbreeding can be practised for generations without doing any appreciable harm; but in other cases it ere long proves hurtful, leading either to loss of size, vigour, or fertility.

Some years ago when in-breeding dogs, the loss of vigour was so marked that I abandoned the experiments. In other cases the vigour is maintained, but there is loss of size or of fertility. But while I found close in-breeding led to unsatisfactory results with dogs, ten years close in-breeding of goats has neither led to loss of vitality nor fertility, neither has it reduced the weight or diminished the size of the horns.

When, in the case of the Infusoria or other unicellular organisms, in-and-in breeding leads to a loss of size, to an almost complete cessation of reproduction, and to changes in the nucleus, a change in the surroundings, in the food, temperature, etc., may for a time arrest the degenerative changes, but unless the members of the in-bred colony are allowed to conjugate with the members of an unrelated brood, *i.e.* unless intercrossing is resorted to, the death of the entire colony is inevitable. In the case of wild and domestic animals suffering from long-continued close in-and-in breeding a change in the environment may for a time arrest senile decay, and lead to partial rejuvenation; but the only effective way to save the race or strain from extinction is intercrossing with more vigorous members of the same race or strain which have been living under different conditions, in a different area, and in all probability developing in a somewhat different direction. There is in all cases a limit beyond which it is undesirable if not impossible for breeders and fanciers to carry their improvements, when, in fact, it becomes increasingly difficult to maintain the standard already established. By following a definite plan, which, as a rule, involves close in-breeding marvellous results are sometimes secured, but there comes a times when, notwithstanding the most careful selection and the most favourable surroundings, deterioration sets in, with the result that the records of former years can no longer be reached.

When this happens in, say, a special strain of the English race-horse, the breeder should at once endeavour by crossing with some other strain to reproduce—to revert to—the vigorous ancestors of a former generation. There is no golden rule for the rejuvenation of a breed. The breeder having realised, if possible, in what points his animals are deficient must act accordingly, always bearing in mind that increased size may not be gained by resorting to a very large strain, increased quality by crossing with a very fine one, nor increased speed by an infusion of fresh blood from a very fleet one. Before leaving the subject of reversion it may be well to inquire why in some cases, even when distinct species are crossed, there is little or no evidence of reversion, while in other cases closely related members of the same race or strain yield offspring in many ways resembling fairly remote ancestors. Why, *e.g.*, is a cross between a Galloway heifer and a Highland bull almost identical with a pure-bred Galloway? and why, *e.g.*, did the pointer bitch, referred to above, produce puppies resembling their great-great-grandam instead of their immediate parents?

When as in the case of Galloway-Highland crosses one of the parents seems to count for everything, all that can be said is that one of the parents is decidedly more prepotent than the other, produces germ plasm so vigorous that in the struggle which presumably takes place between the units or groups of units during development, it not only succeeds in overcoming all the remote ancestors, but, apparently unaided, succeeds in endowing the offspring with at least its external characteristics. When as in the case of the pointer the immediate parents appear to count for little or nothing in the offspring, it can only be said that the immediate ancestors failed to carry the development beyond the phase represented by an ancestor some generations removed, probably because their germ plasm having been deficient in vigour, a latent ancestor had the chance of surging to the surface.

Laws of Heredity.—Until recently the only law of heredity that demanded serious consideration was Galton's law. Now, however, we have in addition Mendel's law, a law which can be tested by experiment.

According to Galton's law of ancestral heredity, the two parents contribute half, the four grandparents one-fourth, the eight great-grandparents one-eighth, and so on, of the total heritage of the average offspring.

Heredity mainly concerns itself with the *transmission of variations.* Variations are of two kinds, namely, (1) new congenital variations, *i.e.* variations (due perhaps to new combinations at the moment of fertilization) which sooner or later make their appearance in every individual as development and growth proceeds; and (2) variations, also congenital, which from time to time made their appearance in the ancestors.

The problem which especially interests students of heredity is, to what extent are the new variations transmitted to the offspring? The problem is complicated by the fact that the offspring, with rare exceptions, are derived not from one but from two germ cells derived from two different individuals which have varied in different directions. If Galton's law holds, it may be assumed that each parent on an average only transmits one-fourth of the new congenital variations. For example, if a blue rock pigeon (owing to inscrutable changes in the germ plasm from which it was developed), instead of having like its parents twelve, has twenty tail feathers, it will, according to Galton's law, only transmit two extra tail feathers (*i.e.* fourteen instead of twelve) to its offspring. If both parents by varying in the same direction happen to have twenty tail feathers, then the offspring will have sixteen tail feathers. If, however, the birds with sixteen tail feathers breed with normal blue rocks, the number will be reduced to thirteen. In fact, unless the birds with sixteen feathers were unusually prepotent, or were in many ways better adapted for their environment than the blue rocks with twelve tail feathers, the new variation would rapidly be lost by reversion to the ancestral type—the new variety or sport would be swamped by intercrossing.[1]

During recent years Galton's law has been very thoroughly studied by Pearson and others. After making countless measurements and observations, Pearson arrived at the conclusion that Galton's law of ancestral inheritance, as far as it referred to the parents, might be accepted as approximately accurate.

It must, however, be admitted that Galton's law fails to explain all the results obtained by breeders and fanciers, and it helps us but little in realising how new varieties of wild plants and animals manage to persist and eventually give rise to new species.

[1] Some years ago a litter of half-wild rabbits I bred were quite tailless, but, by intercrossing, the tailless variety soon disappeared.

Since 1900 a new law of heredity has been engaging the attention of biologists and breeders throughout the civilised world. This is the law promulgated by Gregor Mendel in a paper on "Experiments on Plant Breeding," communicated in 1865 to the Natural History Society of Brünn. Mendel died unknown to fame in 1884. Were he to reappear he would be not a little surprised to find that his work, after years of neglect, is now regarded by some biologists as nearly as epoch-making as the publication of the *Origin of Species.*

That Mendel's law is extremely important will be evident when it is stated that with its help breeders are, amongst other things, able to preserve and fix practically any new variation that from time to time appears, and to blend useful characters of several varieties in one type. The nature of Mendel's law is realised by making a Mendelian experiment. Mendel experimented chiefly with peas, but it may be more instructive to describe a recent experiment with waltzing mice. The race of waltzing mice is said to have originated in Japan. How it originated is unknown, but as four out of six members of a litter of cross-bred rabbits I bred some years ago were in the habit at frequent intervals of spinning round very swiftly in one spot, sometimes from right to left, at other times from left to right, exactly like waltzing mice, it may be assumed the ancestors of the Japanese spinning mice arose spontaneously—in other words were sports. My spinning rabbits varied in colour, but the waltzing mice all agree in having pink eyes and small patches of fawn on the shoulders and rump. Apparently waltzing in mice results from a deficiency in the nerve supply of the semicircular canals of the ear. That it is due to some derangement of the nervous apparatus is suggested by the waltzers being often unable to control their movements, *e.g.*, they sometimes throw the head upwards, at other times as they shuffle backwards, the head is moved from side to side. As the offspring of waltzers always waltz, rigid selection was probably practised when the race was originally formed.

When a waltzing mouse is mated with a normal white mouse the cross (generally termed a hybrid) never waltzes, but in eyes, coat colour, habits, and movements it is almost identical with the common house mouse. The crosses not only have jet black eyes, but they are healthier and more vigorous than even the normal albino parents—were it not that the belly is lighter in colour the hybrid might easily pass for a common house mouse. Hence crossing a waltzing with an albino mouse apparently leads to almost complete reversion to their wild common ancestor. When the hybrids are interbred they produce three kinds of offspring, namely—(1) some of their own (grey-brown) colour with black eyes; (2) some with white eyes and fawn patches or fawn coloured all over, or of a lilac colour, *i.e.* more or less like their waltzing grandparent; and (3) some with white eyes and a white coat like the albino grandparent. When a large number of the second generation are obtained it is found that in colour 25 per cent. resemble the Japanese waltzing variety, 25 per cent. the white albino variety, and 50 per cent. the grey-brown hybrid or first cross. When albino offspring of the hybrids are interbred, they produce only albinos, *i.e.* they breed true, likewise the offspring of the hybrids resembling in colour the waltzing variety when interbred with very rare exceptions breed true, but the grey-brown offspring of the hybrids when interbred behave like the first crosses, *i.e.* produce (1) albinos; (2) individuals closely resembling the waltzing race; and (3) grey-browns resembling like the first cross the wild house mouse.

As similar results have been obtained with pure-bred strains of a large number of plants and animals, it may be assumed that, as a rule,

when hybrids from pure strains are interbred 25 per cent. of the offspring in at least certain characters will resemble one of the varieties experimented with, 25 per cent. the other variety, and that 50 per cent. will resemble (and when again interbred behave like) the first cross or hybrid. Why 25 per cent. of the offspring of the hybrids resemble the one grandparent and 25 per cent. the other, while 50 per cent. retain the characters of the first cross, may be accounted for by saying that one-half of the germ cells produced by the hybrids represent the one original variety, while the other half represent the other variety, that, *e.g.*, 50 per cent. of the germ cells produced by the hybrid mice (*i.e.* the first crosses) are practically as pure as the germ cells of the albino, while 50 per cent. are as pure or nearly as pure as the germ cells of the waltzing mouse. If of 100 ova 50 are albino and 50 waltzing, and if half of the sperms are albino and half waltzing, the albino eggs will have an equal chance of uniting with albino as with waltzing sperms, and the waltzing eggs will have an equal chance of uniting with waltzing as with albino sperms. If half (25) of the albino eggs unite with albino sperms there will be ultimately produced 25 pure albinos, and if half (25) of the waltzing eggs unite with waltzing sperms the result will be 25 waltzers. If the remaining albinos' eggs unite with waltzing sperms and the remaining waltzing eggs unite with albino sperms, the result will be 50 hybrids (second crosses) identical with the first crosses obtained by mating pure albino and waltzing mice.

When instead of directing attention to the colour, the transmission of the waltzing habit is taken into consideration, it is found that the waltzing character is distributed at random amongst the second crosses, to pure albinos and grey-browns as will as fawn-coloured individuals. As the waltzing albinos breed true, it follows that by employing Mendel's methods desirable characters existing in separate strains can be speedily combined in one strain.

The combination into one strain of the desirable characters of several strains has for some time been the subject of experiment at the Cambridge Experimental Farm. Mr. Biffen has succeeded in improving various kinds of wheat, and, more important still, he has found a wheat which is immune to the fungoid pest known as yellow rust—a pest said sometimes to cost Germany £20,000,000 in a single year. If, as seems likely, strains of wheat which are notoriously liable to rust can by crossing on Mendelian lines be made immune to the rust fungus, an enormous saving will be effected in the wheat crop of the world.

I am not aware to what extent animal and plant breeders consciously or unconsciously make use of Mendel's discoveries. I may, however, mention that by working on Mendelian lines I find desirable characters of several varieties can be combined in the same strain of horses. For some years I have been endeavouring to restore a small slender-limbed horse which flourished in Europe and North Africa during the Pleistocene period. By comparing fossil teeth and limb bones found in Pleistocene deposits (in France, England, and Algiers) with the teeth and limb bones of living horses, I arrived at certain conclusions as to the conformation and external characters of a small horse hunted and figured by our Palæolithic ancestors. I then selected horses having one or more of these traits, and took steps to combine as many as possible of the traits in one strain. By crossing a Shetland pony with an Arab, I obtained a filly with a somewhat large head but with a straight croup and fine limbs, having small ergots and small hind chestnuts. By crossing a Connemara mare with a Welsh pony—both showing points supposed to belong to the wild Pleistocene race—I obtained

a colt with a fine head and small callosities, but with drooping quarters and a low set-on tail. This colt was in due time crossed with a Connemara pony, somewhat Arab-like in make, with the result that a colt was obtained with a short broad face, drooping quarters, but the hind chestnuts and ergots small. By mating this Connemara-Welsh mixture with the Arab-Shetland mare I have obtained a colt with a fine head, oblique shoulders, a short back, slender limbs, without ergots and hind chestnuts—a colt which carries its tail exactly like a high-caste Arab, and in almost every point realises one's conception of the small horse which flourished during the Ice Age in various parts of Europe and North Africa.

Mendelism has not only demonstrated that by interbreeding crosses—whether they happen to take after the one variety or the other, or are more or less intermediate—25 per. cent. on an average of each of the pure varieties originally crossed is at once obtained, and that it is possible to speedily combine in one strain characters existing in several strains; it has in addition enabled us to understand why some strains never breed true, throw numerous "wasters," and indicated how decadent breeds can speedily be rejuvenated without either loss of quality or of their distinctive points or traits. It has long been recognised that blue Andalusian fowls never breed true. However carefully bred, only about half the offspring are blue, while the other half are pure black or white with black splashes. With the help of Mendelism it is now realised that blue Andalusians are a cross between a pure black strain and a white-splashed strain. This is proved by the fact that while the blues always produce a number of black and white-splashed "wasters," the blacks and white-splashed always breed true, and when crossed at once yield blue Andalusians. This implies that though only 50 per cent. of blue Andalusians are got by mating the blue with the blue, 100 per cent. of typical blue Andalusians are obtained by mating the black "wasters" with the white-splashed "wasters."

The blue Andalusian breed is one of many so-called breeds made up of two strains which absolutely refuse to blend, *i.e.* a blue Andalusian is a cross or hybrid.

When a strain shows signs of deterioration—loss of size, vigour, or fertility, or becomes extremely liable to suffer from infectious and other diseases—the breeder begins to consider how, without loss of the points which have made his strain famous, he can restore its original vigour. Forgetful of the fact that the deterioration is mainly due to a loss of vitality, the breeder generally decides to use for the rejuvenescence of his flock or herd members from a variety having as many as possible of the points which characterise the strain to be renovated. When, *e.g.*, one of the sections of the so-called British wild cattle requires reinvigorating, a bull is generally obtained from a "wild" herd which in colour and in the horns closely resembles the variety in need of a new lease of life. Recently it was decided to restore the vigour of the almost extinct Chartley herd. Two courses were followed. They were crossed with a Welsh race which appeared to be akin to the Chartley "wild" cattle and with white Highland cattle which in make and horns decidedly differed from the Chartley standard. As anticipated by the Mendelians interested, the Highland-Chartley crosses have very few of the Chartley points, while the Welsh-Chartley crosses closely resemble the old Chartley breed. If the Highland-Chartley heifers are now mated with a Highland-Chartley bull, at least 25 per cent. of the offspring may be expected to present all the original Chartley traits, and yet be more vigorous than their Chartley grandparent. But as the Highland-Chartley crosses are extremely unlike their "wild" ancestors

the probability is they will be got rid of, and the rejuvenation of the "wild" herd entrusted to the Welsh crosses which differ but little from the old Chartley race. I mention this case by way of accentuating the fact that no regard must be paid to the appearance of the first crosses. They may be the image of one of the strains experimented with (as the cross between a Highland heifer and a Galloway bull is the image of a pure Galloway), or they may look decided mongrels, and so completely disappoint the breeder that he has not the courage to carry the experiment further. But however disappointing the first crosses may be when interbred, they will produce offspring some of which are the image of the one strain, some the image of the other.

From what has already been said, it follows that, given one or two fertile members of an old strain, the application of Mendelian methods will enable the breeder to preserve it, and in course of time increase it to any extent. Further, when a sport or new variety makes its appearance (granting that it is fertile and adapted to the available environment), by the application of Mendelian principles it will be possible to create a new strain and perhaps in addition combine the new characters with those of some other strain. The difference between Mendel's law and Galton's law of ancestral heredity will be best understood by an illustration. According to Galton's law, zebra-horse hybrids would inherit one-quarter of their characters from the zebra parent, one-quarter from the horse parent, and the remainder from the ancestors of zebras and horses. Were zebra hybrids fertile when interbred, their offspring would be still less like the zebra and horse grandparents (would inherit only about one-eighth from each), and still more like their remote ancestors, while in the offspring of the second crosses very little evidence of the zebra great-grandparent would be left.

According to Mendel's law 25 per cent. of the offspring of zebra-horse hybrids would be pure zebras which would breed true; 25 per cent. would be horses of the same strain as their horse grandparent, and 50 per cent. would be hybrids which, when interbred, would again include pure zebras and pure horses amongst their offspring. It thus appears that the breeder by following the precepts of Mendel's law can obtain very different results from what Galton's law would lead one to expect. Nevertheless, it is well to bear in mind that as nature's methods are, or at least may be, very different from the methods of the breeder, it is possible that Galton's law more accurately expresses what actually takes place amongst wild animals and plants than Mendel's law.

Intercrossing and Interbreeding.—As in Mendelian experiments intercrossing is usually followed by interbreeding, the influence of these opposing factors on the transmission of variations, *i.e.* on heredity, may next be considered. There is no essential difference between intercrossing and cross-fertilizing on the one hand, and between intercrossing and hybridizing on the other. All three, as a rule, lead to reversion, the amount being usually intimately related to the differences between the forms crossed. When the parents are remotely related, the development is usually arrested sooner than is the case when the parents belong to the same strain or family. When the parents belong to the same strain, only the most recently acquired points may be lost; when they belong to different species all the improvements effected by rigid selection during numerous generations may entirely disappear. The extent of the regression or reversion is, however, regulated by the prepotency. When both parents are prepotent, as, *e.g.*, when Galloway and Aberdeen-Angus (or shorthorn) breeds are crossed, the offspring, instead of reverting, may unite to a

remote ancestor, the more important points of both breeds, and thus illustrate blended inheritance. When one of the parents is prepotent, as, *e.g.*, when Galloway and Highland breeds are crossed, the offspring may closely resemble pure Galloways and thus illustrate exclusive inheritance—the parent which controls the development is said to be *dominant*, the other *recessive.* When neither parent is prepotent as, *e.g.*, when a waltzing mouse is crossed with an albino, the offspring resemble a remote ancestor, and thus illustrate reversion.

Free intercrossing is said to be one of the corner-stones of the breeder's art. But when free intercrossing is possible in a flock or herd of any dimensions, a high level of excellence is seldom reached. Intercrossing, however, produces uniformity, and when the scope is sufficiently wide ensures vigour.

Amongst wild plants and animals, as long as the conditions are stable, natural selection by eliminating individuals likely to disturb the balance, keeps variation in check, and thus there is rarely material for a pronounced cross; but in a changing environment variation is encouraged by natural selection in order to give the species a chance of adapting itself to the new conditions. To breeders, intercrossing is especially useful in two ways. When resorted to in time, and judiciously carried out, it arrests deterioration without any serious loss of the distinctive traits of the strain or family. Further, though intercrossing usually leads to reversion, it often, after prolonged or close in-breeding, induces sporting or variation, and thus gives the breeder a chance of modifying his herd in a new, and, it may be, a better or at least a more profitable direction.

Hitherto it has been commonly assumed that unless the first cross or hybrid is mated with one of the pure strains from which it was obtained, it is useless for breeding purposes. Nevertheless, it is by mating the hybrids with each other—interbreeding the first crosses or half-breeds—that the Mendelian at once restores the pure breeds from which they were derived, and now and again obtains new breeds, and it is by intercrossing hybrids that he now and again succeeds in combining the desirable characters of several strains into one.

When the value of Mendel's law is more clearly realised, intercrossing will doubtless become more than ever one of the chief corner-stones of the breeder's art, and not only resorted to when there is a loss in size, vigour, and fertility.

Interbreeding or in-and-in breeding is also regarded as a corner-stone of the breeder's art. In fact it has been by in-breeding that all the improved breeds have been formed, and it is by in-breeding that most of them are maintained. Sometimes the in-breeding has been very close. The value of in-breeding has been insisted on by all authorities on breeding. That it has been widely practised is testified by practically every stud-book. Osborne, "the ablest authority living on British thoroughbreds," in *The Horse-breeders' Handbook*, 1889, wrote: "I consider the breeders of the present day are not so clever as their predecessors in mating their mares; they have lost sight of the necessity of in-breeding—*i.e.* keeping in the same family." What he means is made evident by a further statement to the effect "that you cannot now get too much of Birdcatcher." That in former generations close in-breeding was practised is made evident by the history of the famous bull Comet. "The bull Bolingbroke and the cow Phœnix, which were more closely related to each other than half brother and sister, were coupled, and produced the bull Favourite. Favourite was then coupled with his dam and produced the cow Young

Phœnix. He was then coupled with his own daughter (Young Phœnix), and their produce was the world-famed Comet." The cow Restless was even more in-bred than Comet, and I could quote examples of still closer consanguineous breeding from my own stud-books.

The object of in-breeding has ostensibly been to fix the type. When, as a result of sporting, of intercrossing, or of selection, a new variety presenting desirable characters has appeared, haphazard interbreeding has been practised with a view to creating a new strain. The more stud-books are investigated, the more obvious it becomes that the in-breeding has not been carried on systematically. The in-breeder has not clearly realised that in-breeding, if successful, eventually leads to the production of pure germ cells. The breeder on Mendelian lines, on the other hand, has both a definite object and a definite plan. He aims at obtaining pure germ cells, and the plan he adopts is to interbreed the hybrids or first crosses. The procedure of a Mendelian is best represented by an example. Suppose A. represents one variety and B. another, the hybrid resulting from crossing A. with B. will equal A. B. But the germ cells produced by hybrids, instead of being hybrids like the individuals in which they are lodged, are as pure as the germ cells of the grandparents, *i.e.* they are either A. *or* B. When two pure varieties (A. and B.) are crossed, the germ cells have no option; unless A. unites with B. there are no offspring. But if the germ cells produced by the hybrids (A. B.) are either A. *or* B.—as pure as the germ cells of the grandparents—it follows the A.'s have a chance of uniting with A.'s as well as with B.'s, and the B.'s have a chance of uniting with B.'s as well as with A.'s, and thus giving rise to offspring identical with the varieties A. and B. originally crossed, as well as to offspring identical with the hybrids.

Hence interbreeding the hybrids leads to the production of a generation consisting partly of pure individuals (A. *or* B.) and partly of hybrids (A. B.). As it happens, the ordinary breeder and the breeder on Mendelian lines have exactly the same object in view when they resort to interbreeding; they both aim at obtaining pure breeds.

If the ordinary breeder succeeds in fixing his type, his success is due to his having obtained by accident, rather than by design, pure germ cells. But sometimes the breeder fails to fix the type. This happens when he endeavours to make a new breed out of hybrids, such as the blue Andalusian fowls, and when for any reason it is impossible to combine the desired points into one strain. Without pure germ cells no true breed can be established, however close the in-breeding. Whether the pure breed is formed by a roundabout process or speedily restored by Mendelian methods, the result is the same, and there is no reason for supposing that a pure variety, restored by interbreeding hybrids on Mendelian lines, is more liable to suffer from the effects of in-breeding than a pure variety obtained by haphazard interbreeding, or that if a new strain results from interbreeding hybrids (*e.g.* the recently formed lilac-coloured mouse and the rust-resisting variety of wheat), it will be less vigorous than the strains created by Bakewell, Colling, Bates, and other experimenters of a former generation. It may be well to point out that when intercrossing is resorted to in order to arrest degeneration, the amount of rejuvenation will in all probability be related to the number of hybrids employed in the renovating process, and how many strains took part in producing the hybrids. From what has been said, it follows that to speedily make or rejuvenate a strain, breeders must give up the long-cherished view that all constancy is lost in crosses other than first crosses. It is doubtless true that, as Darwin pointed out, the offspring of the first generation are generally uniform; but it is not always true that those sub-

sequently produced display an almost infinite diversity of character, for when the first crosses are interbred, 50 per cent. of the offspring (*i.e.* of the second generation) resemble their parents, and 25 per cent. resemble each of the grandparents.

PREPOTENCY AND HEREDITY.—It is extremely difficult to estimate what influence prepotency has in the transmission of variations. It is an easy matter to mention numerous examples of prepotency, but it is impossible to account for prepotency, because, as Darwin said, "the subject of prepotency is extremely intricate." When an animal or plant is highly prepotent—has acquired prepotency by in-breeding or by varying in some unaccountable way —the immediate offspring, not being so liable to be arrested in their development, to regress towards mediocrity, may, even when hybrids, reproduce all or nearly all the points of the prepotent parent. A remarkable instance of prepotency we have when a cross-bred piebald mare produces a foal nearly the image of herself to an in-bred high-caste Arab (this happened in my stud some years ago); and a still more remarkable instance we have when a spotted mare produces a spotted mule to a brown Poitou ass. In many of the Mendelian experiments recorded, the hybrids are almost identical with one of the varieties crossed—the prepotent variety is hence known as the *dominant* variety, the variety which appears to count for nothing as the *recessive* variety. When, however, hybrids, the image of one of the parents, are crossed they yield the usual number of recessives. It is true that the offspring of such hybrids seem to consist of 75 per cent. of dominants, but further experiments prove that only 25 per cent. of these breed true—the others being hybrids which behave like those resulting from the original cross.

It thus appears that prepotency does not in any way interfere with the operation of Mendel's law, does not prevent the formation of germ cells capable of reproducing pure specimens of the recessive variety.

What influence prepotency has in the evolution of wild plants and animals it is difficult to say. In as far as prepotency arrests reversion, it will make for progress, and if in any way prepotent varieties are better adapted than non-prepotent varieties for the environment, evolution may be accelerated.

When breeders cross with a sire of a highly prepotent strain and obtain only offspring resembling this sire, they are at first apt to exaggerate the influence of prepotency. They get a very uniform first generation, but when they interbreed the crosses or mate them with unrelated varieties, instead of uniformity there may be that "infinite diversity" proverbially associated with second crosses.

That some individuals and strains are more capable than others of transmitting their characters has not only been long recognised, it has led to a considerable amount of speculation and inquiry without, it must be confessed, any very certain conclusions being arrived at. It has often been asked, Is the wild parent more prepotent than the tame? In all my experiments with rabbits the wild variety invariably proved prepotent. The wolf seems to be invariably prepotent over the dog. A wild ass from the Himalayas (*Equus onager*) proved prepotent when crossed with Mongol, Exmoor, and other ponies; the Exmoor hybrid very closely resembles the wild sire, and is nearly as intractable. On the other hand, a hybrid (now three years old) between the wild horse of Mongolia (*E. przevalskii*) and a Hebridean pony takes after his dam—except for the semi-erect mane, poorly developed forelock, and short hair at the root of the tail, it might pass for an ordinary pony; some of the crosses between a wild Indian rock pigeon

(*Columba livia*) and a house pigeon closely resembled their cross-bred dam; some the wild sire. That the Przevalsky hybrid, unlike the Onager hybrid, took after the tame parent may have been due to the fact that at the time the wild stallion was mated with the Barra mare he was in a reduced state owing to the presence of the parasite *Strongylus* which some months afterwards caused his death. This view is, I think, supported by the pigeon experiments. The offspring of the Indian blue-rock for some time after he arrived from India in no way suggested the wild parent. For some months after reaching Scotland his blood contained the *Halteridium* parasite. Later, when the parasite disappeared and the wild bird was in good feather his offspring by the same female presented all the points of the wild parent. Sometimes hybrids resemble the wild parent, at other times the tame. All my zebra hybrids were more like zebras than horses in colour, make, and temperament, but of three hybrids bred by Lady Meux out of a Burchell zebra mare, by three different sires, one was very richly striped; in a second the markings, though indistinct, were numerous; but in a third, said to be by an Iceland or Shetland pony, the markings were few and inconspicuous; apart from the mane and tail this hybrid differed but little from a pony. From these instances it may, I think, be inferred that, as a rule, the wild variety will prove dominant, be more likely than the tame to control the development—perhaps partly because the germ cells are usually purer, and partly because the wild form having benefited by rigid natural selection is more vigorous. Another question is often asked, namely, Is the male more prepotent than the female? It would be easy to give instances in which the male parent proved dominant, and instances in which the female parent proved dominant. Nevertheless, other things being equal, it may be assumed the male will, as a rule, prove more prepotent than the female, especially when the male is polygamous. This view is supported by results obtained in studs where mules and hinnies are bred. Mules (hybrids between a male ass and ordinary mares) are usually more asinine than equine; on the other hand, hinnies (hybrids between a male horse and she-asses) are usually more equine than asinine, *i.e.* both mules and hinnies take more after the sire than the dam. How far this results from polygamous sires (wild as well as tame) being, as a rule, in better condition than the dams, it is impossible to say. Reference may here be made to a view especially associated with the name of Mr. James Howard, namely, that the male parent is mainly responsible for the external structure, configuration, outward characteristics, colour, and the locomotive system, while the female parent supplies the internal structure, the vital organs, and, in a larger proportion than the male, the constitution, temper, and habits. Many individual cases could doubtless be quoted in support of the view that, "the sire influences what we can see, the colour and anatomy; and the female what we cannot see, *i.e.* the internal organs"; but when whole families, litters, and broods are taken into consideration, there seems to be as much evidence in support of the view that the dam influences what we see and the sire the internal anatomy. Huxley thought it probable that "every part of the adult contains molecules derived from both the male and the female parents, and that, regarded as a mass of molecules, the entire organism may be compared to a web of which the warp is derived from the female and the woof from the male." Without doubt "molecules" derived from the male as well as the female occur in every cell of the body, but they are so equally and evenly distributed that it is impossible to regard molecules derived from one parent as providing a framework for those obtained from the other. Every breeder can doubtless recall instances of some of the off-

spring of the same parents resembling in their external characters the sire, while others as faithfully reproduced the more striking features of the dam. I have already referred to a Przevalsky hybrid, which closely resembles his pony dam, and to an Onager hybrid which as closely resembles the wild sire, and many equally striking cases could be mentioned. There is no *a priori* reason, as far as I can see, why the offspring should in their outward traits or locomotive system favour the sire more than the dam. The immature male and female germ cells have the same history, origin, and structure, and the mature germ cells only differ in that the eggs contain more or less food material (yolk) for the nourishment of the embryo during development.

During fertilization the sperm not only supplies nuclear rods or chromosomes—the so-called carriers of heredity—but also cytoplasm, hence the male, notwithstanding the minute size of the sperm cell, in all probability, takes as large a share as the female in forming the soma or body of the offspring.

In studying heredity one must think of the germ cells rather than of the individuals by which they are nurtured and protected. According to the latest view, both male and female germ cells are to start with hermaphrodite — the eggs containing male as well as female protoplasm, the sperms female as well male protoplasm. At the reducing division the female germ cell becomes male *or* female, and at the last division of the male germ cell male and female sperms are produced. According to this view, the sex of the future offspring is settled before the egg is fertilized, and fertilization mainly consists in supplying maleness to the eggs which during the reducing division lost male protoplasm, and femaleness to the eggs which at the reducing division lost female protoplasm. If the agreement between the eggs and sperms is so complete and fundamental, it is extremely unlikely that they invariably play different parts during development, that one concerns itself with the form and external characters, while the other is concerned with the formation of the nervous and alimentary systems.

As the nervous system is developed from the same embryonic layer as the skin, the presumption is that the temper and habits, coat colour, and other external characteristics will be inherited from the same parent—not the colour from one parent and the temperament from the other, as believers in Howard's creed believe.

Another question is, Are pure breeds more prepotent than cross breeds? When a grey-brown cross between an albino and a waltzing mouse is bred with a pure albino, half the offspring are albinos and half grey-browns, *i.e.* they are equally potent.

Nevertheless the general experience of breeders is that pedigree animals are more prepotent than half-bred and cross-bred animals. Frequently cross-bred horses have proved dominant in my stud. For example, a yellow-dun stallion obtained by crossing a light-grey Connemara mare by a black Welsh cob almost invariably obtained light-dun offspring with the mane and tail nearly white. One of the light-dun silver-maned sons of the half-bred Connemara stallion out of a cross-bred dappled dun Connemara mare, obtained white-dun foals out of the following mares: a bay mare imported from Java, a half-Arab chestnut mare, a chestnut Iceland mare, and a mouse-dun Shetland mare.

Many other questions raised by a consideration of prepotency might be considered, but only two more need be referred to, namely, Does age influence prepotency, and are some colours more easily transmitted than others?

From experiments with rabbits and pigeons, I arrived at the conclusion that, other things being equal, prepotency increases with age until what may be called the zenith is reached, and that the prepotency of each egg is greater immediately after it reaches maturity, *i.e.* soon after the reducing division, than it is immediately before degenerative changes set in. If these conclusions hold, it follows that an individual might be non-prepotent if bred from as soon as maturity is reached (*i.e.* as soon as the germ cells ripen), but decidedly prepotent though given the same mate at a subsequent period.

Recently considerable attention has been directed to the transmission of coat colour in horses—a subject of great interest and of considerable practical importance. The inheritance of colour in Percheron horses has been studied by Mr. E. H. Harper in America, while the inheritance of coat colour in thoroughbreds has been investigated in England by Mr. C. C. Hurst. In Percherons until recently grey was the predominant colour, but as a result of artificial selection blacks have recently been on the increase. According to Roberts, "About 1820 two noted grey Oriental stallions, Godolphin and Gallipoli, were introduced into the Government stables at Pin. These two prepotent stallions fixed the style of colour and fastened it on an already susceptible breed. . . . The colour of most Percherons is grey of varied shades. Sometimes it is quite light, becoming nearly pure white in old age. Again, the striking light and dark dapples are seen, and dark greys, almost black, with a few white hairs. Comparatively few blacks have as yet (1905) been bred, although dark colours are sought and are more common than formerly. The American purchaser prefers darker rather than lighter colours; hence the effort in France is to produce darker coloured animals than formerly." In the Percheron, as might have been anticipated, the long predominant grey colour is prepotent over black, and the tendency is to revert to the original grey colour. In the case of three hundred greys investigated 75 per cent. had grey parents, while in a similar number of blacks only 60 per cent. had black parents. Nevertheless, if the selection of blacks continues, greys will be eliminated from the Percheron breed.

Mr. Harper has, in addition to demonstrating that in the Percheron grey is prepotent over black, made out—(1) that the dam is prepotent over the sire in the ratio of about five to four—grey dams being more prepotent than black dams and grey sires than black sires, grey dams than grey sires, and black dams than black sires; (2) that there is apparently a degree of correlation between age and prepotency—the prepotency increasing with age up to about middle life, when it reaches a maximum.

The study of Weatherby's General Stud-Book of Race Horses led Mr. Hurst to the conclusion that bay and brown are prepotent over chestnut.[1] In support of this conclusion it is shown that 370 foals out of chestnut mares by bay or brown sires[2] were all bay or brown. With the exception of one (St. Serf) which had a chestnut grandparent, all the sires had bay or brown parents and grandparents. When bay and brown sires having a chestnut parent[3] or a chestnut grandparent[4] or a chestnut great-grandparent (Ayrshire) or a chestnut great-great-grandparent (Florizel II.) are mated with chestnut mares, about half the foals (355) are bay or brown, and half (347) chestnut. On the other

[1] Chestnuts are distinguished by the absence of black points.
[2] The sires were St. Simon, St. Serf, Galopin, Ladas, Merry Hampton, and Cabin Boy.
[3] Royal Hampton, St. Angelo, Isinglass, Orvieto, Isonomy, Melton, and Wisdom.
[4] Donovan, Pioneer, and Rose Window.

hand, recessive chestnuts descended from bays and browns breed true, that is, only with rare exceptions yield bay or brown foals. According to Mr. Hurst, these results are "in accordance with the Mendelian expectation."

In my experiments I have found—(1) that a yellow-dun mare may prove prepotent when mated with a black sire; (2) that yellow-dun mares mated with yellow-dun sires may produce not only yellow-dun offspring, but also bays and chestnuts; (3) that yellow-dun mares mated with chestnut sires may give bays and white duns with a silver mane and tail; (4) that yellow-dun mares with bay sires may yield bays, blacks, chestnuts, and red roans. These observations help us to understand how, by the blending of yellow-dun wild ancestors, the black, white-dun, chestnut, bay, roan, and other colours now found amongst domestic horses may have originated.

Transmission of acquired character.—Up to well-nigh the end of the nineteenth century the transmission of non-congenital variations (*i.e.* of characters not latent in the germ plasm, but acquired by the body or soma before or after birth) was so firmly believed in by biologists as well as breeders that it was hardly considered necessary to submit evidence in support of the transmission doctrine. Though biologists now with rare exceptions admit that only the variations represented in the germ plasm when the act of fertilization is completed can appear in the offspring, many breeders still adhere to the doctrine of transmission associated with the name of Lamarck, and to the last regarded as possible, in at least a modified form, by Darwin. Biologists have ceased to believe in the transmission of variations acquired by the body or soma for two reasons—(1) because the doctrine is not supported by experiments, and (2) because though the vigour or vitality of the germ cells may vary with the condition of the individual by which they are sheltered and nourished, it is now inconceivable that any modifications, mental or physical, the body or soma may undergo before or after birth can be engrafted on the germ plasm, which in due time will, if an opportunity offers, take part in forming a new generation.

There are three kinds of variations, namely, (1) the variations inherited by each parent from the immediate ancestors, (2) the new variations formed when the male and female germ cells blend during fertilization, and (3) the variations (or modifications) produced by the environment during development and growth. The first two kinds of variations are heritable, the third, *i.e.* the non-germinal variations, are non-heritable, and are hence of no use to the breeder.

Amongst acquired characters are included modifications due to use and disuse of any part of the body, to mutilations, and to disease. "All the effects of exercise are acquirements—for example, the enlargement which exercise causes on muscles. The effects of lack of exercise are also acquirements—for example, the wasting of a disused muscle. The effects of injury are acquirements—for example, changes in a diseased lung or injured arm. Every modification of the mind is also an acquirement—for example, everything stored within the memory. If a man be blinded by accident or disease, his blindness is acquired; but if he come into the world blind, if he be blind "by nature," his blindness is inborn. If a son be naturally smaller than his father, his inferiority of size is inborn; but if his growth be stunted by ill-health, or lack of nourishment or exercise, his inferiority is acquired (*Alcoholism: A Study in Heredity*, p. 9, by G. Archdall Reid). It seems to be extremely difficult not only for breeders, but also at the outset for students of heredity, to believe that evolution is possible, that a

race or strain can be improved, unless mental and physical modifications acquired through the influence of the environment are transmitted to the offspring. Progressive variation seems to be so much simplified by assuming that at least some acquired variations are transmitted, some of the skill acquired by the craftsmen of one generation is handed on to the next, that the offspring of mathematicians and musicians, philosophers and scholars, find mathematics and music, philosophy and classics, easier than would have been the case had their respective fathers failed to make strenuous use of their respective talents, that in at least some cases the absence of tails in puppies is due to the amputation of the tails of the parents, that thoroughbreds are fleet because their ancestors for many generations were trained for the racecourse, that deer have horns because the butting of their remote ancestors produced bosses, which further butting converted into long branching bony outgrowths.

When a student is at the stage when progress seems impossible, unless non-congenital as well as inborn characters are transmitted, to tell him evolution has resulted from variation and selection makes him feel as if he were given a stone when he is hungering for bread.

Telegony.—Though the belief in telegony (that "the influence of the first male by which a female produces young may frequently be seen in her future offspring by different sires," Darwin) is no longer so firmly held, it still enters largely into the calculations of many breeders. Telegony ("infection of the germ" of older writers) means that not only the immediate parent but also the previous mates (if any) contribute to the characters of the offspring. Believers in this doctrine hold that in some cases infection is beneficial, in others the reverse. If, for example, a mare which had produced foals to, say, Ladas and Persimmon, thereafter produced a foal to, say, Spearmint, the last foal in addition to inheriting characters from the actual parents might benefit by inheriting traits from Ladas and Persimmon, former mates of the dam. If, however, a thoroughbred mare had first a foal by a Shire, her subsequent foals to thoroughbred sires might through throwing back to the former mate (the Shire) of their dam prove useless on the racecourse. Some breeders not only believe a female may be infected by her first mate, but that if repeatedly put to the same mate she gets more and more saturated with the characters of that mate, and not a few even believe that a sire may transmit definite structural characters from one mate to another, that, *e.g.*, a shorthorn bull that has been running with Galloway cows may subsequently infect shorthorn cows with Galloway characters. Obviously, if there is such a thing as telegony, if it is possible to blend, without the risks of intercrossing, the characteristics of several individuals or varieties, progressive development would be greatly accelerated. Though the doctrine of "infection" has probably long formed part of the breeder's creed, it received but little attention from men of science until in 1820 Lord Morton communicated a case of infection to the Royal Society, which in due time was published in the *Philosophical Transactions.* In this the most credible and best authenticated of all the cases of telegony on record, a chestnut mare, after rearing a quagga hybrid, produced to a black Arabian horse three foals of a peculiar bay colour, one of them (a filly) showing more stripes than the quagga hybrid, and, according to the stud groom in charge of "the colts," characterised by a mane "which from the first was short, stiff, and upright."[1] Darwin, after fully considering Lord Morton's case, came to the conclusion that the chestnut mare had been infected, and this case along with others led him to believe

[1] *Phil. Trans.*, 1820, p. 21.

that the first male influenced "the progeny subsequently borne by the mother to other males."[1] If the upright zebra-like mane in one of the pure-bred colts and the markings on all three were the result of the chestnut mare having been first mated with a quagga, there is undoubtedly such a thing as telegony, and the presumption is that other mares first mated with a quagga or zebra and then with a black Arabian would give birth to striped offspring with a stiff if not quite upright mane. The evidence that from the first the mane of the filly was short, stiff, and upright is not very satisfactory. It consists of an allegation by a stud groom. That the mane was upright, as in the quagga and zebra, is *a priori* improbable—(1) because the mane of the quagga hybrid instead of being short and stiff was long and lank enough to arch to one side of the neck; (2) because the mane of zebra hybrids throughout the greater part of the year is so long that it falls to one or it may be both sides of the neck; and (3) because in the Equidæ an upright mane is always accompanied by a tail deficient of hairs at the root—in the filly the tail was as perfect as that of her Arab sire. We have still stronger evidence that the allegation of the groom was unfounded from drawings (of the chestnut mare, her three "colts," the black Arab, the quagga, and the quagga hybrid) by Agasse, a very reliable animal painter of the early part of last century. In the drawing of the filly the mane is represented as lying to one side, as in Arabs and other well-bred horses. The pictures (now in the Museum of the Royal College of Surgeons, London) were made because the subsequent foals were believed to prove the truth of the "infection" doctrine. Had the mane of the filly been erect it would hardly have escaped the keen eye of the artist. But had Agasse by any chance missed this all-important detail, Lord Morton or some of those interested would doubtless have called his attention to the matter. If the mane of an Arab is completely removed early in the spring it is stiff, and upright in the autumn, but hanging to one side close to the neck in the following summer. When the whole circumstances are taken into consideration, there seems to me no escape from the conclusion that the mane of the filly was upright when seen by Lord Morton in August 1820, and lying to one side when painted by Agasse the following summer, because it had been regularly cropped or at least hogged some months before Lord Morton's visit. But whatever be the explanation of the want of agreement between the mane as seen by Lord Morton and as depicted by Agasse, it will, I think, be admitted that the evidence afforded by the mane of the filly is hardly sufficient to establish the truth of the doctrine of telegony. Of still less value is the evidence afforded by the make, coat colour, and markings which were apparently too indistinct to deserve the name of stripes. The colts were decidedly Arab-like, of a bay colour marked more or less "in a darker tint." Judging from Agasse's drawings, they closely resemble Arab-Indian crosses; they are, in fact, in make very like an Arab-Kathiawar horse once in the possession of Lord Arthur Cecil. I have seen a bay Highland cob with as many stripes as Lord Morton's colts, and pure-bred Arabs of a dun colour with stripes on the neck and far more distinct leg bars than those depicted by Agasse. I believe the colts owed their stripes and colour, not to "infection" of their dam by her previous mate the quagga, but to reversion. It is quite possible the black Arabian horse was of mixed origin; that the chestnut mare was cross-bred is admitted. As in the west of Ireland the offspring of black and chestnut ponies are sometimes of a decidedly dun colour, it is not surprising the black Arab and the half-bred chestnut had bay offspring. Neither are the stripes surprising. I recently

[1] *Animals and Plants*, vol. ii. pp. 435, 436.

ascertained that the chestnut mare was presented to Lord Morton (while serving with his regiment in India) by one of his officers—Mr. Boswell of Deeside, Aberdeenshire—and that she was most likely a cross between an Arab and a country-bred pony. In Kathiawar the ponies when pure bred are of a dun colour and more or less richly striped. If in the chestnut mare there was any Kathiawar or even any native pony blood, its offspring to a black sire might have been expected to be of a dun colour and striped. In a word, there is no reason for assuming that the foals would have been less striped if the chestnut mare had been mated with the black Arab first and the quagga afterwards.

By way of testing the truth of the "infection" doctrine, I started, in 1895, a number of experiments, and especially arranged to repeat, as accurately as possible, what is commonly called Lord Morton's experiment. Since then twelve mares, after producing sixteen zebra hybrids, a mule, and a hinny, have had an opportunity of supporting the telegony hypothesis by giving birth to twenty-two pure-bred foals.

During the same period the Baron de Parana of Brazil bred at least six zebra hybrids, and some of the dams of these hybrids subsequently produced ordinary foals. Further, Baron de Parana has for a number of years been engaged in crossing cattle and in watching the results obtained in several mule-breeding establishments, where from 400 to 1000 brood mares are kept. As in these establishments the mares breed mules and horses alternately—two or three mules and then a horse foal—there has been carried on for some years, under the observation of Baron de Parana, a telegony experiment on a gigantic scale.

The single hybrid bred by Lord Morton had extremely few stripes, and only in a remote way suggested a member of the zebra family. All my hybrids, like those bred in Brazil, have more stripes than their zebra sire, and in some of them the bands are nearly as conspicuous as in some of the zebras, thus proving that both the mares (which varied in colour and breed) and the two zebra stallions used were well adapted for the experiment. The results of my experiments, not only with the Equidæ, but also with other domestic quadrupeds and birds, all point to the conclusion that there is no such thing as telegony, and the same conclusion has been independently arrived at by Baron de Parana in Brazil. Believers in telegony—they are numerous in America, India, and Australasia, as well as in England—almost always say of the many experiments recently made with a view to giving "infection" a chance of showing itself, that they have only yielded negative results, and they generally add, it is impossible to prove a negative. After carefully considering all the more striking so-called cases of "infection," I have no hesitation in saying that there is no satisfactory evidence that there has ever been, either in the human family or amongst domestic animals, a single instance of "infection."

Maternal impressions.—More remarkable than the belief in telegony is the belief that maternal impressions can be transmitted. This doctrine, which has held its own since at least the days of the skilful shepherd who peeled wands and stuck them before the fulsome ewes, seems to have received a new lease of life. Professor Wallace in his recently published work says, "The colour of any object at which an animal looks while conceiving, or during the early stages of pregnancy, may sometimes govern the colour of the young."[1]

The following amongst other examples are given as evidence in support of "the influence of the imagination." About 1860, "a black Clydesdale

[1] *Farm Live Stock of Great Britain*, p. 12. 1907.

mare that worked alongside a chestnut gelding, and as long as she was associated with him her foals were all chestnut. When he died the new mate was grey and the first foal born after the change was grey."[1]

Nothing is said about the sires of the foals either before or after the mare lost her chestnut mate, or of the breeding of the mare. To account for the appearance of the grey foal by the doctrine of maternal impressions is little short of an appeal to the supernatural without first endeavouring to find one of many possible natural explanations.

Evidence of a different kind is supposed to be afforded by a breeder of polled Angus cattle who prevented his cows dropping "red or broken-coloured calves by putting up a high black fence round the paddock in which he mated them . . . thus preventing their seeing the parti-coloured cattle of his neighbour."[2]

It must be admitted that it is difficult to imagine how "the high black fence" influenced the imagination of the polled Angus cattle in Scotland; or how in certain parts of England, as another authority tells, whitewashed byres produce light coloured calves regardless of the colour of the parents; or how fowls, however carefully penned, are liable to hatch birds resembling in colour the hens they habitually see in a neighbouring run.[3]

If maternal impressions thus influence the offspring, they must be one of the most effective causes of variation. During the last twelve years I have bred many hundreds of animals, but the nearest approach to an instance of maternal impressions was a dark pup with a white ring half round the neck, which suggested the white metal collar sometimes worn by his sire. But similar rings round the legs and tail rather discredited the view that the white neck-ring was in any way related to the sire's nickle-plated collar. Telegony was sometimes said to be due to maternal impressions. It was doubtless for this reason that I was urged to carefully prevent the mares used in my telegony experiments from seeing too much of the zebras. But though numerous foals have been bred from mares stabled with zebras or grazing with richly striped zebra hybrids, not a particle of evidence have I found in support of the maternal impression doctrine. The foals have neither stripes nor upright manes, and do not even attempt to mock the weird barking call of their striped companions. Experiments with sheep and cattle, goats, rabbits, and guinea-pigs, fowls and pigeons, have simply confirmed the results obtained with horses. This being the case, grooms may very well omit following the practice (considered so essential in Spain during the Middle Ages, and still sometimes observed in England and America) of setting "before the mares . . . the most goodly beasts" by way of hinting to them the kind of foals they are expected to produce.

Hereford Cattle.—It may well be said that the Hereford can lay claim to being an original and not a composite breed of cattle; and to have been bred in a state of purity for as long, or perhaps longer, than any other of the recognised pure breeds of the present day. In the year 1886 there was published a *History of Hereford Cattle* by Messrs. James Macdonald and James Sinclair, and at that time the present writer had a good deal to do in assisting the authors to collect all the information that was possible as to the early history of the breed. That book is now out of print,

[1] *Farm Live Stock of Great Britain*, p. 12. 1907. [2] *Ibid.*
[3] Bibby's *Quarterly, Autumn Number*, p. 163. 1900.

and under the circumstances we cannot do better than quote several of the authorities which were referred to in that publication which show the antiquity of this race of cattle. There is no doubt a great similarity, especially in colour, between the cattle of Herefordshire, Devonshire, and Sussex, except that the white face has now been definitely established on the otherwise red groundwork of the colouring of the Hereford. The first question which arises is, How did this white face and other white markings of the Hereford assert themselves? whereas the cattle of Devon and Sussex remain whole-coloured red.

As early as the reign of King John we have an account of a breed of cattle which were in high estimation in the Welsh border county of Hereford (said by Rowlandson to be Brecknockshire), and which were white with red ears—as stated in the chronicles of Hollinshed, Anno 1211. It is written in an old history of Flanders, according to this authority printed at Lyons by Guillaume Rouille in 1562, that Maud de Bress, who was the "wife of the Lord William de Breuse, presented once upon a time to the Queen of England a gift of 500 kine, and one bull of colour all white the ears excepted, which were red. This was a present in order to purchase peace for her offending lord, who was one of the Lords of the Marches." There is a suggestion that these cattle have some connection with the wild white cattle of Chillingham and those collected in Vaynol Park, near Bangor, in North Wales, by the late Mr. Assheton Smith. Some of these cattle used to be in considerable numbers in Wales, and it is probable that some of this historical white colouring became engrafted into the red stock of Herefordshire. This idea may possibly be confirmed by the fact that up till quite recent times there was a strain of grey Herefords of recognised purity.

The question of the white face has many different solutions, but the earliest authentic one seems to be that given by Mr. Thomas Andrew Knight of Downton Castle, near Ludlow. He was born in 1759, and was himself one of the early improvers of the Hereford. His opinion was that the superior quality of the breed was in some measure due to the introduction of a breed of cattle which Lord Scudamore imported from Flanders, which were red with white faces. Lord Scudamore died in 1671. It seems to be pretty certain that these imported cattle had considerable influence on the native breed of Herefordshire, and helped to put on the stamp of the white face. In Mr. Cooke's volume on the history of Herefordshire there is a reference to the family of Hereford, several members of which were in the Netherlands during the seventeenth century, and it is remarked: "These gentlemen are traditionally credited with having procured in Flanders, for Lord Scudimore, the cattle from which the celebrated herds of the county are descended." This may be said to be a brief summary of all that is known of the earliest history of the Hereford, but we come to the conclusion that it is substantially correct, or it would not have been accepted by such a high authority in all matters connected with his own county as Mr. Andrew Knight, who was one of the most distinguished men of his time, being President of the London Horticultural Society, and was a member of many different scientific societies. The United States and Sweden, among other countries, recognised his labours in the world of science and natural history. Mr. Knight was a noted breeder of the famous "Knight Greys" as they were called, and some of the best cattle of the breed trace their descent to his herd.

Now we come to an historical fact, that in 1788 there was a distinct pure breed in Herefordshire—whose "colour was a middle red with a bald

face, the last being esteemed characteristic of the true Herefordshire breed." Marshall, who wrote the *Rural Economy of Gloucestershire, etc., in* 1788–89, makes this statement, and he further wrote: "The Herefordshire breed of cattle, taking it all in all, may without risk, I believe, be deemed the first breed of cattle in this island." Marshall also wrote that at the Hereford fair on October 20, 1788, he saw about a thousand head of cattle chiefly of the Herefordshire breed; and adds, "The most valuable collections I have met with out of Smithfield, by much the finest show I have anywhere seen."

It has been asserted by some that Benjamin Tomkins, who lived from 1745 to 1815, was the founder of the Hereford as we now have it; but although Tomkins was perhaps one of the most prominent of the early breeders, and founded a strain of his own, the same may be fairly said of Tully, Skyrme, Galliers, and Haywood. I will say something of these breeders in the order named. The stock of Richard Tomkins must have been considered of some value, as it is specially mentioned in his will in 1720. His son Benjamin, born in 1714 and died 1789, inherited the cow Silver and her calf, and was one of the first improvers of the breed. Benjamin Tomkins was the father of the celebrated founder of what was called the Tomkins "breed," and this Benjamin Tomkins was born in 1748 and died in 1815. He was contemporary with Bakewell, and these men in their different ways had a lasting influence on the pedigree live stock of Britain.

Mr. Eyton in the appendix of the first volume of the Hereford Herd Book, quoting Low as his authority, says Tomkins' herd originated about the year 1766. This herd, according to the evidence collected by Mr. Eyton from his daughter and others, was commenced by the purchase of two heifers and a bull, the one being grey and the other a red with a spotted face; the former was called Pigeon, the latter Mottle. During the later part of his life Benjamin Tomkins used no other bulls except those of his own breeding. He once drove twenty cows to Hereford on the day of the agricultural show and offered 100 guineas to anyone who could show an equal number superior to them, and the offer was not accepted.

We do not think that the evidence is at all conclusive that the two cows, Pigeon and Mottle, were the direct ancestors of Benjamin Tomkins' herd, but were bought on account of their special high merit, and particularly because of their great aptitude to fatten; and as a good cross for those cattle he must have most undoubtedly been able to get from his father's herd, who had in his turn obtained them by will from the Richard Tomkins above mentioned. The fact of his having a Silver strain in his herd points to the probability of that portion of it tracing back to the cow Silver, bred by his grandfather. The Silver strain were in colour red with white face and having more or less white along the back. It will be seen then that Tomkins did not stick particularly to one colour, but favoured the "red with white face," the "mottle face," and the "grey" all alike. It was these three colours which caused a deep-rooted jealousy among the breeders from that time for many years; and as each party would have nothing to do with the others as far as the interchange of blood, if possible, it led to a good deal of in-and-in breeding, and considerable harm to the breed generally in the forward movement for its advancement. It is this lack of combination, which has even up to the present day not entirely disappeared, which has prevented the extension of the Hereford breed into other parts of Great Britain, as would otherwise have been the case in a greater degree than at present.

Parsons.

HEREFORD BULL.

Parsons.

HEREFORD COW.

Tomkins' idea was that flesh and form were more important than colour, and no doubt he was right at that early development of the breed. Tomkins always considered his Silver Bull so named, and (41) in the first volume of the Herd Book, was the best he ever had. This bull was red with white face, and had a little white on his back; his dam was called Silver—and hence his name. This Silver Bull (41) in all probability came from the line of the old Silver cow left by will by Richard Tomkins, his grandfather. It may therefore, we believe, be safely said that the modern Herefords of this strain trace back to the Silver of 1720.

To confirm the statement that Tomkins' cattle were is high repute: in 1819, four years after Benjamin Tomkins' death, a bull called Phœnix (55) in the Herd Book was purchased at a sale of Miss Tomkins' cattle by Lord Talbot for 560 guineas. Phœnix is described in the Herd Book as being mottle face, bred by Mr. B. Tomkins, Wellington, dam Storrell by Wild Bull (145); g.d. Storrell by a Pigeon bull bred by Mr. Tomkins. Wild Bull (145) was by Silver Bull (41). These pedigrees, I think, show pretty plainly that the best of the Tomkins' Herefords were descended from the Silver Bull (41), and have their origin also from the Silver cow of 1720 in the female line. It also confirms the belief that Benjamin Tomkins mixed the Pigeon and Mottle strains irrespective of colour with the old blood of his father and grandfather.

The Herd Book records show how largely the Tomkins' blood as represented by this judicious policy, and by considering as of the first importance the shape and form of the animal together with aptitude for laying on flesh, were appreciated by the leading breeders of the day. Knight, Smythies, Yarworth, Hewer, Walker, Hoskyns, Perry, Jellicoe, Smith, Lord Talbot, Sir F. Lawley and others all used this source largely in the foundation of their herds.

With regard to colour, Mr. Knight obtained the greys from the Tully strain, the dark reds from Tomkins, and the pale reds from Skyrme. Little is known, however, of the foundation of the herds of Tully or Skyrme, but the Tully cattle are found taking prominent places at all the early shows both at the Smithfield and Herefordshire; while at the first show of the Royal Agricultural Society in 1839 the first prize cow is stated in vol. i. of the Herd Book to have been Huntington, bred by Mr. Tully. Many of Mr. Westcar's oxen, including the winner of the first prize at Smithfield in 1799, were bred by one or the other of the Tullys. It is stated in *Bingley's British Quadrupeds*, 1890, that Mr. Tully of Huntington fatted an ox to 1928 lb., the fat weighed 288 lb., the tongue was sold for a guinea, and the hide for 3 guineas.

William Skyrme of Stretton had a strain of light red colour inclining to yellow with the faces occasionally faintly ticked or speckled. Mr. Knight's opinion was that the strains above mentioned were about the best that the country possessed at the end of the eighteenth century.

William Galliers of Wigmore Grange, near Lenwardine (the present home of the well-known breeder of Herefords, Mr. George Green), was closely connected in the breeding of early Herefords with the elder Benjamin Tomkins. This family owned cattle which took many prizes at the Herefordshire Agricultural Society shows between 1802 and 1813. Mr. Galliers was born in 1713 and died in 1779. The herd at Wigmore Grange passsd into the possession of his son, and it is believed that the account of the sale of his cattle on 15th October 1795 is the earliest on record of the breed. The names of the purchasers and the prices paid

prove that the Galliers cattle were much appreciated at that time. Mr. Jeffreys of The Grove, Mr. Turner of Aymestry (an ancestor of the present well-known breeder and judge of Herefords, Mr. Arthur Turner of The Leen), bought some of the best, Mr. Turner giving £32, 5s. for a two-year-old heifer, and Mr. Smith of Shellesley paid £26, 5s. for a cow called Gentle. It must be remembered that money was of a somewhat different value at the time, and the prices paid really represented higher value than it possibly appears to us at the present day.

The Galliers herd had originally a good deal of mottle face colour, but they gradually became altogether red with white face; this information was obtained by Messrs. Macdonald and Sinclair in 1886 from a relation of the family, who remembered some of the old mottle-faced variety being in existence in her grandfather's herd. This Mr. William Galliers at one time lived at Frogdon, and was a brother to John, whose sale is described above. He afterwards went to Lynch Court, where he bred the celebrated bull Cupid (260), and from this foundation through Young Cupid (259) the celebrated herd of the Rev. R. J. Smythies was laid. Mr. Smythies was a personal friend of the writer, who was well acquainted with his herd which he kept at the Wetmoor Farm, near Craven Arms, when he resided with his life-long friend and contemporary breeder Mr. J. B. Green at Marlow Lodge. Mr. Green bred some of his best Herefords from the Jeffreys stock, who, as above stated, was one of the purchasers at the Wigmore sale. And as Galliers and Tomkins were great friends and bred their cattle on the same lines, it will be seen that the better known name of the Tomkins strain was also passed on down to future breeders to a great extent through the Galliers cattle.

The family of Haywood must be mentioned, and then we will pass on to more modern times, but referring before we do so to several important sales which are recorded in the Hereford Herd Book. A Mr. John Haywood had a large herd descended chiefly from Tomkins and Price of Ryall. Mr. Henry Haywood, with whom the present writer worked on the Editing Committee and Council of the Hereford Herd Book, had in his possession a picture by Weaver of the celebrated bull Prize-fighter, which bears the following inscription: "Prize-fighter, bred by Samuel Haywood, the property of Mr. Gwilliam of Purslow, Shropshire, shown at Shifnal, 28th December 1800, by Mr. Tench of Bromfield, against Mr. Knowles of Nailstone, Leicestershire, to decide a bet of 100 guineas, determined in favour of the Herefordshire by Mr. Pester, Somersetshire." I take this and the following from Macdonald and Sinclair's book, which gives my own description of this animal from a print I had in my own house, which was published in the book alluded to.

"The colour of some of the cattle belonging to the Haywoods was dark red with very little white. Mr. John Hill of Felhampton Court, who owns a painting of Prize-fighter, and who had placed at our disposal the whole of his valuable collection of documents relating to the breed, thus described the colour: 'White boss with red hair among it, and shaded with white over left eye and dingy white blaze, a little white round the jaw, and a white throat-line; horns white with black tips; white flag to tail; no other white of any sort.'" This bull became the property of Mr. Gwilliam of Purslow Hall, Shropshire, so that it may be taken for granted that his herd was closely connected with that of the Haywoods. And, as a proof of the estimation in which the Gwilliam cattle were held, at a sale in October 1808 a cow and calf were sold to Sir Walkin Wynn for £225, 15s.; a heifer and a calf sold for £121, 16s., and three bull calves realised £169, 1s.

The whole of the cows averaged £65, 8s. 6d. each. This speaks well for value of this line of breeding at that time; and the late Mr. Henry Haywood's herd at Blakemere at the time we knew him was in high reputation in the county of Hereford, and was largely drawn upon by American buyers in the eighties of the last century.

Space will not allow me to go more fully into the merits of all the individual breeders, but from what has been briefly stated above readers may gain some general information as to early development of the Hereford breed. It will be gathered from the above notes that the early breeders had no common type or colour for their aim, but each followed out his own ideas as to what he considered should be the characteristic of the breed. Size and weight, coupled with an aptitude to lay on flesh when the oxen had finished their years of labour on the farms, seem to have been the chief point common to them all.

The modern type of white-faced Hereford has been only gradually evolved through a long course of years; and we will try to follow this course by mentioning some of the chief items of historical interest. Before doing so, however, we will give a short account of several of the most important early sales and successes of the Herefords at the Smithfield and other shows, and a description of what a Hereford should be, which we wrote for the *Agricultural Gazette Almanac*, 1885, entitled "How I Judge Herefords." This was published in the *History of Herefords*, above referred to.

In the first volume of the Hereford Herd Book, Mr. Eyton published a full account of Miss Tomkins' sale at Kings-Pion on 18th October 1819. For forty-two lots the amount realised was £4673, 14s., and fifty-two head of cattle calves included averaged £89, 17s. 6d. each. In this number there were included seventeen two-year-old and yearling steers. The best prices obtained for cows were £262, 10s., £210, £252, 5s., and £273. The highest price paid for a bull was £588—of which mention has already been made.

Mr. John Price held a sale of his Herefords at Ryall, near Upton-upon-Severn, on 16th, 17th, and 18th October 1816. About the year 1804 Mr. Price became acquainted with the stock of Benjamin Tomkins, from whom he bought a few cows, and some of the best animals he possessed came from this foundation; he tried hard to induce Mr. Tomkins to sell one favourite cow, and although he offered £250 he failed to secure her. Mr. Price obtained £212, 5s., £110, 5s., £120, 15s. for cows; £173, 5s. for a three-year-old heifer, £252 for a two-year-old heifer, and £189 for a yearling heifer; while bull calves made up to £126, £262, 10s., £341, 5s., £262, 10s., £115, 10s., £136, 10s., £147, and £283, 10s. This latter sum was given by Mr. Jellicoe for Wellington (4); he was bred by Mr. B. Tomkins, was mottle-faced, and said to be the best Hereford he ever had except Silver Bull (41). The prices quoted are those which exceeded a hundred pounds, but they ruled high throughout the three days' sale. On 15th October 1841 Mr. Price had another sale, and the first cow in the catalogue was Toby Pigeon; she was then twenty-two years old, and is probably one of the most famous cows in Hereford history. Nearly the whole of Mr. Price's herd has descended from this grand old cow. At nineteen years old she had had nineteen calves, having been served by Chance when very young, and at three or four years old had twins. The bull Washington (35) was her last calf; he was sold at the sale in 1841 when a yearling for £66, and was afterwards bought by Lord Talbot for £166. One of the best bulls Toby Pigeon ever bred was Trueboy (14); he was by Trusty (15), whose sire Triumph (8) was a son of

Woodcock Pigeon out of the old cow, so that he was closely inbred to Benjamin Tomkins' favourite strain. All these bulls were mottle-faced, so that it is evident that Toby Pigeon combined the two lines of breeding with which Benjamin Tomkins hoped at the commencement of his career to improve his herd, getting the grey colour through Pigeon, and the mottle-faced through Mottle. We cannot say for certain what colour Toby Pigeon herself was, but probably mottle-faced, although being full of grey blood she threw some of her stock of that colour. Thus, Patriot (30) was a light grey; he was out of Blue Pigeon, a daughter of Toby Pigeon, and by Young Woodman (12), which was a grey bull, and also a son of the Toby Pigeon. Her name will also connect her with the original Pigeon which was known to be grey. Young Trueboy (32) transmitted the grey colour through a son of his, also called Young Trueboy (1475), into the later herds of Lord Berwick and others. Some of the best cattle I had in my own herd at Felhampton Court were descended from this stock, notably the well-known sire Merry Monarch, of which I will make further mention later on.

Before leaving the subject of early sales I must go back some years, having rather run too far over the line. The Smithfield Show in London is perhaps the earliest of the series which we need consider. These shows were first established in 1798, when the Society was called the "Smithfield Cattle and Sheep Society," not taking its present name "The Smithfield Club" until 1802. In 1799 a Hereford ox won the first prize at this show, when all breeds were shown together in competition with each other. The exhibitor was Mr. Westcar of Creslow, Buckinghamshire, who was one of the founders of the Society, and this exhibitor took the first prize against all breeds in open competition at Smithfield for twenty years in succession. At the first show Mr. Westcar's ox measured 8 feet 11 inches long, 6 feet 7 inches high, 10 feet 4 inches girth, and was sold for 100 guineas. This information was given by Mr. Thomas Duckham (editor of the Hereford Herd Book) in a lecture delivered on Hereford cattle to the students of Cirencester Agricultural College in 1863, and he obtained it from the official record of the Smithfield Club by its Secretary, Mr. Brandreth Gibbs.

This Mr. Westcar sold twenty Hereford oxen at different periods from 1799 to 1811, at an average of £106, 6s. each, at prices ranging from £100 to £147. My old friend the Rev. Mr. Smythies of Marlow Lodge made this extract from Mr. Westcar's sale book, and gave the information to Mr. Duckham for his lecture at Cirencester. I further quote the following from this lecture: "As far as we can learn, . . . during the time they were shown in competition, the Hereford oxen and steers won 185 prizes, the shorthorns 82, the Devons 44, the Scotch 43, the Sussex 9, the longhorns 4, and crossbreds 8 . . . this in itself cannot fail to prove their superiority as a flesh-producing race of cattle."

The following is from the *History of Herefords*, above referred to. I should say that the present writer formerly resided at Felhampton Court, Church Stretton, and bred Hereford cattle from 1868 to 1898:—

"As to the features that are to be looked for in the modern tpyical Hereford, we do not think we can do better than quote the following from the pen of Mr. John Hill of Felhampton Court:

"'In judging Herefords cattle at breeding shows, in my opinion too little attention is paid to the question of whether the animals brought into the ring are in a healthy breeding condition or not. I believe the judges should first satisfy themselves on this point, especially in the older classes.

If they have been fed abnormally fat and cannot walk freely and easily, and are bad upon their legs and feet, or even go cramped and crippled, I should certainly vote for their rejection at once.

"'When judging a bull, I should look for a good masculine character and a pronounced style and good carriage, which should intimate that he is likely to stamp his progeny with his own form and attributes. A bull without these characteristics is almost sure not to be a good and impressive sire. The head should be well set on, not carried too low or stuck on like a pig's, as some are. It should not be narrow or too long, but wide between the eyes, which should be full and prominent yet mild, showing a quiet disposition and aptitude to fatten. I like a good wide muzzle and clear nose. Usually a good body follows a good head. I would never give a prize to a bull with an effeminate weak head if I could find another in the class at all passable, and failing such I would withhold the prize. The crest should be well developed and have a good white mane. I do not fancy Herefords without some white on their shoulders, although, of course, its absence is no great point against an animal; and I dislike a bull with narrow crops, and think this is a very bad fault, for Herefords are most emphatically a beef breed, and narrow chines are most objectionable where beef is wanted; on the other hand, the narrow chine is a special attribute of the deep-milking sorts, for example, the Jerseys. A young bull having good crops, wide between the top of the shoulder-blades, and having a good fore-flank, will, even if he is not quite filled up behind the shoulder, nearly always "come" in that place as he matures; so that it should not be thought a very great fault if he is deficient there. A good back is a point that should carry a great deal of weight with the judges. A bad-backed one should be put on one side, as most of the best cuts of beef worth most per pound come from that part. . . . Long, full hindquarters and well-developed wide thighs, well let down to the hocks, should score many points, and narrow thighs should always be considered one of the greatest faults. Perhaps I should have mentioned before that I consider quality counter-balances a multitude of other faults, and I should always reject an animal that did not handle well, as, failing this, they can never feed. Good hair, and plenty of it, is also a *desideratum*. Of course at the summer shows many animals have lost their coats, but there is always plenty of evidence of what their winter coats are, which a practised eye can tell at once. I like a beast which stands over plenty of ground, and with his legs well outside him, the belly line as close to the ground as possible, without being "tubby." A big bony animal is certainly to be avoided, but a little size as well as quality must be an advantage to all concerned, for when you have done weighing you have done selling.

"'In the case of cows and heifers, it is difficult to ignore the fact that they are in a breeding condition when they have calves by their sides, even though they may be grossly overfed. Still there should be a limit, and I think it an objection to an animal being shown as a breeder, if it is in a fit state to be shown immediately afterwards at a fat stock show. I like a clear-cut delicate head, with the same features that I mentioned above for bulls, but with a nice feminine character, instead of the bull's masculine appearance. A "gay" head need not be objected to, provided the horns are not cocked up and turned back—"upturned" horns are very different from "cock" horns. A bull-like, coarse head is the worst kind to my mind, as it gives no style and smartness to the animal. I am not fond of the very dark reds, as I believe those of a lighter colour—not too pale—feed quicker, and are usually of better quality. Beauty of form and symmetry should always be

considered by the judges as two strong points in favour of the animals possessing them.'"

As the writer of the above description of what, in my opinion, a Hereford ought be, I can only say that after a lapse of twenty years and more, I do not wish to alter it any way, and do not think I could add anything further to be of any value to my readers on this subject.

No history of Herefords would be complete without a mention of the Hewer family. William Hewer was born in 1757. The Hewer cattle nearly all trace back to a bull called Silver (540), which was white-faced and was calved in 1797, bred by William Hewer of Hardwick. His son John was born in 1789 and died 1873. It appears from the published correspondence between Mr. Yarworth (who had a good herd at that time) and Mr. William Hewer, that at a very early period of his career he bought five cows from Tully of Huntington, and that he had in his herd descendants from "Tomkins' prime cattle." The bull Sovereign (404), the sire of Cotmore (376), the winner of the first prize for Herefords at the Oxford meeting of the Royal Agricultural Society in 1839, was bred by Mr. John Hewer. He was calved in 1820, and was let to different leading breeders of the day for sums amounting to £640, 18s.; he died in his fifteenth year; he was an offspring of an own brother and sister Old Favourite (442) and Countess by Waxy (403) by Old Wellington (507), and he was by Silver (540). All these bulls were red with white face, and this colour was so distinctive of the Hewer cattle that some people asserted that he was the originator of the white faces. This, however, from what has been written in this article is shown to be erroneous, as red with white-faced cattle evidently existed before the earliest authentic records of the breed.

Although the Hewer cattle were of this colour, there was no doubt a strong strain of mottle face in their composition. The mottle was not very distinctly marked, but it might be seen in small so-called ticks on the white grounding which sometimes looked like streaks of bluish-grey under the white. I am old enough to have been present at John Hewer's last sale in 1872, and remember some of his very best cows had this marking. John Hewer was a great believer in scale and quality, and was in the habit of letting out for hire a number of his bulls, thirty-five being out on hire from his herd in one season; and some of these used to go to Scotland. Some of his older bulls were of great size; General (1251) weighed 32½ cwt. when six years old, and was let for the season at £100. Mr. John Hewer's son has stated that he has heard his father say that he had let Favourite for £200 for season, as also Defiance (416). John Hewer had four favourite strains—Countess, Lofty, Red Rose, and Fanny—from which cows nearly all his best animals descended. His career as a breeder extended from about 1803 to 1873. The fact of his letting out so many bulls accounts in a great measure for the extensive infusion of his strain of blood into so many herds, and it may be safely said that there is no herd of any repute in the present day which cannot trace to the Hewer foundation.

Mr. Jeffreys of The Grove used John Hewer bulls extensively, including Lottery, Sovereign, and Byron, and with the greatest success, as is proved by his having bred Cotmore (376) which was by Sovereign. A further remarkable instance of the value of Hewer's cattle was Chance (348), the sire of that wonderful bull Sir David (349), who was first at the Royal Show in 1847, and with cow and offspring in 1849, also first prize together with a sweepstakes open to all England at the Ludlow Society Show in 1848 and 1849, and with four of his offspring in 1848 at Ludlow, and a similar prize at Leominster Agricultural Society in the same year. He ended his career

at the age of fifteen years when the property of that eminent breeder Lord Berwick of Cronkhill, Shropshire. Sir David is one of those bulls which has left his impress on the breed in a remarkable manner, and being an inbred bull—his sire and dam both being by Chance—no doubt made him a still more impressive sire than he otherwise would have been. His sire Chance (348) was from a cow called Victoria, by Lottery (410), g.dam Countess by Sovereign (404), which is all Hewer blood. Chance was bred by Mr. Turner, Woke Court, who also used Hewer bulls largely in his famous herd.

In concluding this brief account of the Hewers' work I draw the conclusion that as it has been shown that William Hewer obtained some of his best cattle from Tully and Tomkins, that those old strains have come down through the herd of his son John Hewer and his contemporary breeder Jeffreys of The Grove, to the present day. As I have said, the bull Chance (348) had Lottery and Sovereign in his pedigree, and these were both Hewer bulls, and used by Jeffreys. He was the sire of Sir David, whose sire and dam being both by Chance, stamps him at once as having the Hewer blood concentrated in his veins. Then through Sir David in a direct sequence we get the history-making bulls Sir Benjamin, Sir Thomas, Sir Roger, down to the world-renowned Lord Wilton, which extraordinarily impressive sire was knocked down at public auction, at the dispersion sale of the Stocktonbury Herefords on the death of their owner Mr. Carwardine, in August 1884, for 3800 guineas.

Hessian Fly.—*See* Corn and Grass Pests.

Hickory, The.—Natural order *Juglandiæ*; genus *Carya* (*Hicoria*, Sargent). The hickories form a genus of handsome forest trees, chiefly from North America, where eleven distinct species have been recognised. They have a general resemblance to walnut trees in foliage and fruit, but the two genera may always be distinguished by the pith of the shoots, which is solid in the hickories and chambered in the walnuts, and by the outer husk of the fruit, which is four-cleft in the hickories, and consists of a single piece in the walnuts. In the United Kingdom hickory is only found occasionally planted as a lawn or park tree. It is rather singular that it has not been tried as a forest tree, for it appears to thrive well in Britain, isolated large and vigorous specimens being established here and there in the southern and midland counties.

Those species are most likely to succeed in England which grow in the more northerly American States, especially the shell-bark hickory (*Carya alba* or *Hicoria ovata*), which provides the hickory nuts of commerce, and the timber of which is heavy, hard, tough, and close-grained, light brown in colour, much used for carriage building, agricultural implements, axe-handles, etc. It used to be in great request in this country as the best material for fishing-rods, until it was superseded by greenheart.

There are eleven distinct species of North American hickory, but some of these grow in the Southern States, and are not likely to endure the British climate.

Highland Cattle.—In Scotland, if not furth of it, there is a general agreement that the Highland breed of cattle is the oldest and

purest of the bovine races which are to be found in the United Kingdom. The origin of the breed has been a matter of learned and unlearned conjecture. We do not even know when the breed assumed a large share of that distinctive character which was so much admired during the eighteenth century by occasional English and other visitors to the Scottish Highlands. The cattle can be traced back beyond the Rebellion period of "Forty-five" through the medium of family histories, traditions, song and floating "sgeuls," as a race of strongly marked individuality, differing in no leading essential from the breed as we know it in modern times. It was a standard breed in at least one part of Strathmore at the middle of the eighteenth century, but its history in the Highland glens is lost in the mists of time. Very old men who were to the fore in Perth and Argyll during the "sixties" of the past century were wont to say that the breed was reputed to be of ancient origin when their grandfathers and great-grandfathers were alive. The majority of those who were most concerned with the evolution of the cattle did not even in the rare cases in which they were able, put a scratch of a quill to paper for the enlightenment of succeeding generations. Some of the nineteenth century classifications, such as Highland, North Highland, West Highland, and Kyloe, were purely empirical in a sense. Their fault was that they put a racial value on the plain results of environment and in-breeding, while they practically disregarded the evidence on behalf of a far from remote common foundation.

When and by whom the breed was introduced into the Western Isles no one can tell. Mr. Colin Campbell of Jura in a communication to the writer, states that the fold of cattle owned by his forebear, Mr. Archibald Campbell, was accounted a very old one in 1764, when a large sale was held comprising the whole of the stock on one of the farms. The family tradition is that the fold was founded with animals taken from the mainland. In the case of the Balranald cattle, the late Mr. Alexander Macdonald, an enthusiast in Highland lore, was not able to find a foundation for his fold. His ten predecessors on the property had the cattle, and the further tradition was that his race, which had occupied Balranald or its neighbourhood from the fourteenth century, always kept the native stock. On the mainland the very name of "fold" as applied to an owner's collection of Highland cattle, takes one back to the "lifting" days, when it was often a matter of urgency to guard the stocks at nightfall in stout enclosures. Apart from the Islands, Poltalloch has probably the honour of owning the oldest fold now in existence, as it was founded in 1790.

Hints regarding the colours of the cattle carry one far back in Highland annals, but they still leave an impression of hopelessness on the mind of the searcher after some definite information concerning the animals themselves. *Crodh dubh* (black cattle) is too indefinite, but *Crodh donn* (brown cattle) and the derivative *donnag* are more direct, as they give a far reach of background to a characteristic combination of colour, which is now on the way towards being bred out because it has had arrayed against it the powerful factor of modern fashion.

From the early decades of last century down to recent years many breeders had a strong liking for the *chaishfhionn* or white-marked animals, and the *dubh chiar* stock or the blacks with white underlines have still their fanciers. The *dubh chiar* strains, again, were the evolvers of the *sgiathach*—"winged" or white-scalloped animals, In all likelihood the darker colours were predominant when the cattle with the exception of small lots of cows had to fend for themselves during winter.

The old opinion was that the blacks were the hardiest. Brindles and

Reid.

HIGHLAND BULL.

Reid.

HIGHLAND COW.

reds were very good if not quite so independent during a storm, and browns were frequently excellent milkers. The *chaisfhionn* animals were the best of feeders, and the yellows, according to the notions of others, did well if they had some shelter when winter was at its worst. One must suppose that the views of the old Highland observers had some foundation in fact. It is possible even now to agree with much that was laid down by Gaelic-speaking men of another day. The blacks were probably worthy of their compliments, although fewer of that colour are now in demand; rusty browns and dark reds with black muzzles and tails are undesirable, but there might well enough be a share of space still for the very best of mellow blacks touched with brown. The *chaisfhionn* strains might be preserved, but the yellows, along with the light reds, a few of the red brindles and silver duns, must have a good position in the colour scheme. In olden days the breed was largely kept to the darker shades, especially in the West Highlands, by a supposed meteorologic necessity.

Fancy with its backing of money now orders a considerable play upon the lighter hues, and one is forced to admit that there are fewer admirers than of yore for broken colours. Artistically if not commercially that is an advance. In a representative fold all the standard colours ought to have a place, the more generally popular being of course in predominance. A couple of red brindles, a black and a silver dun form an attractive modern set-off against some eight or nine light reds and yellows. An occasional black-brindle with flesh-coloured muzzle or medium dun makes an agreeable variant. From what has been noted it will be understood that there is never any strong general demand for black, black-brindle, and dun bulls.

The breed cannot be said to have had its one distinct overmastering Bakewell, Watson, or M'Combie; but when the Longhorns of the English Midlands were still unimproved and when the Teeswaters had scarcely taken regular form, the Highland breed was fixed in character and guided by many who had full appreciation of its merit. It early attracted the attention of the peculiarly keen Thomas Bates when he was setting out on his course as shorthorn improver. The long hindquarters and wonderful hair of the old breed were steadily admired by Bates, but his reticence regarding the full history of his finest crosses between the shorthorn bulls and the Argyll heifers is a disappointment to seekers after knowledge. It is known that the "half-bred" bull Laird became one of the valued sires in the shorthorn herd, but apart from that fact there are no trustworthy hints touching further "blending" interests.

At the beginning of the past century Glenlyon and the Trossachs country were famous for their Highland cattle. Members of the Stewart family took a special position as improvers of the old breed. How much it owes to the two brothers, Mr. Donald Stewart and Mr. Archibald Stewart, no one can estimate. The former, the older of the two, and father of the late Mr. John Stewart of Ensay, left Glenlyon for Lewis in 1802, and he was joined shortly after by his brother at the farm of Park, where the two established a fold with the finest of their Perthshire stock and the best they could secure in the West. In 1809, Mr. Donald Stewart took the farm of Luskentyre, in Harris, where he bred grand cattle for almost half a century. Mr. John Stewart, who was born in 1825, had a good selection out of the Luskentyre fold when he set out on his own account as breeder at Duntulm in 1844. Of striking and commanding presence, he had a full share of the family genius as evolver, and by 1882, when he removed his cattle to Scorrybrick and Ensay—to the latter of which he had fallen heir

on the death of his uncle—Duntulm was a great name in the Highland ranks.

It was frequently remarked that the late Mr. John Stewart rarely went in search of an experimental out-cross for his cattle. As a matter of fact, a broad foundation had been laid by Mr. Donald Stewart, who appeared to have a strong belief in the policy of mating the best Island families of cows with the finest bulls which he could secure in Perthshire. In Skye he saw no cattle to equal those at Corrie, and in the Trossachs and its neighbourhood he found no fold superior to that at Monachyle. Mr. D. A. Stewart, the present owner of Ensay, says that the bulls Monachyle and Craig-an-Righ, whose names are to be seen at the foundations of several Ensay and allied pedigrees, were bred at Monachyle. Tarble Herrach, a bull which had considerable moulding influence, was bred at Luskentyre, and Corriechatchan, which proved an excellent cross for Perthshire descended females, was bred at Corrie. Mr. John Stewart had the good fortune to fall heir to grand families of cows, the best being the Guanachs, descended from a cow bought by his father at Corrie; the Tarrgeals from a heifer taken out of Glenlyon in 1802; the Shellays from Harris or the island of Shellay on the outer side; and the Donnachs, probably of western origin.

The breed had a wide range of the country and ample patronage during the early decades of the past century. It knew no real opposition in the genuine Highlands. On the eastern verge of its old kingdom there were stirrings in the Humlie and Doddie camps which indicated danger, but in the heart of Perth, Inverness, Ross, Sutherland, Dumbarton, Argyll, and far as the spread of the Western Isles, natives who believed in the old breed of cattle could hum to the sentiment of "The Glen's Mine." For extraordinary displays of the breed at the National and other shows, one must drop down to a later period. The high-water mark of general excellence was perhaps reached between the late fifties of the century and the early eighties. Since that time the females of the breed have often come almost, if not entirely, up to the great standard which was set in pastorally and agriculturally prosperous times, but the bulls have only now and then reminded the older critics of exhibitions removed from them by the goodly space of thirty or forty years. Some allowance must be made for the strength of early impressions. Beyond that there is the fact that the breed has lost much of its old feeding range. It is in far fewer hands, and such being the case, the difficulty of picking exceptional lots for showing is increased. Putting the matter generally, there are fewer of the very small cattle which were wont to be seen when existing veterans were young, but very heavy cows and bulls are scarcer.

In the twenties and thirties of the past century, the cattle were shown at the exhibitions of the Highland Society by such men as Sir John Maxwell, Bart. of Pollok; Mr. John Dickson, Duns; Mr. John Boswell of Kingcausie; Mr. Donald Macdonald, Balquhidder; Mr. Peter M'Intyre, Tighnablair, Comrie; the Duke of Gordon; Earl Gower; the Marquis of Stafford; the Earl of Ormelie; Mr. Charles Stewart of Chesthill; the Marquis of Breadalbane, whose name appears for the first time on the list of 1836; Mr. Colin Campbell of Jura; Mr. Donald Stewart, Luskentyre; Mr. Alexander Stewart, Mains of Dalvey; and the Duke of Sutherland. Between 1820 and 1840 or a few years later the cattle bred by the "Chesthill" Stewarts, as they were named, at Auch, Cashlie, and Chesthill had a great reputation all over Scotland. Between 1830 and 1840 the stock held by Mr. Charles Stewart were probably at their best, and his brother Mr. John Stewart had an exceptionally fine fold at Cashlie. Those

stocks were guided by acknowledged masters of the breeding art, and the influence of the cattle on other folds was remarkable. They gave an impetus to Taymouth and Urlar in a special degree, and through those folds they had a sway over the breed at large. Between 1840 and 1850, the Marquis of Breadalbane gained many distinctions at the Highland Society with cattle of extraordinary merit. The Duke of Sutherland had also a full share of honours, with generally excellent animals. One of the most successful exhibitors otherwise was Mr. William Grant, Ruthven, Banff, who showed great judgment in selecting first-class animals as well as in bringing them out. Some of his best stock were from Luskentyre and Chesthill. Apart from those referred to, other prominent winners were—Mr. A. G. Morrison, Salachan, Ardgour; Mr. Donald M'Laren, Glenartney; and Mr. Donald Stewart, Luskentyre. On the Braes of Foss in Perthshire, Mr. John Anderson kept excellent cattle in those years, and a bull of his breeding won for the Marquis of Breadalbane in 1846.

In course of the fifties of the century the Taymouth cattle steadily improved until they had undoubted supremacy. The fold was founded about 1830 with the best animals that could be found in the country. Some excellent females were secured from Chesthill, and for a good many years "Chesthill" himself was at command of the Marquis as adviser. Taymouth in those years was at its finest for grazing. Its fresh, rich, well-sheltered pastures and kindly wintering grew cattle to a size which astonished the holders of exposed and at times pinched glen ranges. The wide, noble-looking heads of the cows, their deep heavy frames, substantial bones, rich hair, and generally milky appearance, were the admiration of all visitors. One or two strains in the fold were rather long and strong from eye to nostril, but that minor imperfection was excused in the summing up of breed virtues which touched the crest of the ideal. In the West at Luing, the Marquis also kept a fold for many years, and the two collections effected remarkable improvements at times through interchanges of blood. When the cattle came to be dispersed in 1863 they were practically at their best; they had achieved fame in Highlands and Lowlands, and the time with its run of prosperity in grazing and cropping was favourable for the striking of remunerative prices. It was a great sale for the times, with £35 to £43 for three- and four-year-old bullocks; £136 for a two-year-old bull (Donull Ruadh); up to £57 for cows; £125 for three-year-old heifers; £71 for two-year-olds; and £46 for one-year-olds. The sale held the most distinguished position for prices until the greater portion of the Kinnaird Castle fold came to the hammer in 1905, when seventy-eight head of breeding animals averaged £48, 12s. At that sale four cows went at £105, £110, 5s., £136, 10s., and £210; three three-year-old heifers at £141, 15s., £199, 10s., and £199, 10s.; one two-year-old at £210; and one yearling at £105. Duke George of Athole secured the largest and finest all-round draft of female animals at Taymouth and the noted two-year-old Donull Ruadh (144), one of the best bulls ever calved, whether regard be had to showing or to stock purposes. Very fine drafts were also taken by Mr. John Malcolm of Poltalloch and the Duke of Hamilton. A large number of tenant-farmers looked on while Dukes and other great land-owners were making matters lively.

In the crowd surrounding the Taymouth sale-ring one of the most interested of spectators was the late Mr. John Stewart, Bochastle, a born judge of an animal. Mr. Stewart, to his after regret, was not a buyer on that day, but he made very large amends to himself for what he was accustomed to term a temporary lack of courage, by purchasing privately

at Old Blair and at Atholl spare stock sales animals of the most highly prized strains of blood. Mr. Stewart's earlier purchases from Atholl included the bulls Glentilt (295) and Daibhidh Buidhe; a black Dubh Chiar cow, the ancestress of the Ardtornish Sgiathachs; another black cow Mairi Dubh, the grand-dam of Mairi Dhubh of Bochastle (1299); and N'Odhar, the grand-dam of Proiseag Dubh (783). By means of such purchases, and his own remarkable judgment in making the most of them, Mr. Stewart came rapidly to the front. Then came handsome offers from the late Mr. James Duncan of Benmore for some of the finest animals at Bochastle. In one season Mr. Stewart sent to Benmore a grand lot of nine three-year-old heifers, among them a dun Sgiathach and a black Nannie, and with them he forwarded the famous bull Roderick Dubh. A temporary back-set was given to Bochastle by such sales, but a great set-off was accorded to what came to be classed as an admirable fold "founded on sugar."

As indicated in a preceding paragraph, the breed entered in course of the fifties on a singularly brilliant exhibiting career. The Marquis of Breadalbane; the Right Honourable Duncan Macneill of Colonsay; Mr. Donald M'Laren, Corrychrone, Callander; the Duke of Sutherland; Mr. Richard D. Campbell of Jura; Mr. Allan Pollock of Broom; Messrs. Smith of Minmore, who won in the bull class at the Paris International show of 1856 against Mr. Malcolm, Mr. Alexander Stewart, Dalvey, Mr. Allan Pollock, and the Honourable Lady Menzies; Mr. John M'Laren, Monzie, Blair-Athole; and even Lady Pigot, who some time afterwards won fame in the shorthorn sphere, joined with many others in taking the old breed out to the national shows of Scotland. Monachyle-bred stock were winning many prizes in those years for a number of enthusiastic men, and the like could be said of the Jura animals. Duntulm was then building up a great reputation apart from the national showyards. At the Glasgow Highland Show of 1857 the best bull of the breed was adjudged to be Mr. Richard D. Campbell's Calum Dubh of Poltalloch (76), a stately looking three-year-old of Mr. Neil Campbell's breeding from Mhaldag, a member of the Ribhinn family by the Luskentyre Prince Charlie II., a representative of the noted Guanachs.

A famous bull was seen at the Perth Highland Show of 1861 in the Marquis of Breadalbane's five-year-old brindle Duntroon (177), sire of the great bull Donull Ruadh (144), which passed two years later into the possession of the Duke of Athole. On the same day Mr. Donald M'Laren won with the lovely yellow cow whose slightly idealised likeness by Gourlay Steell adorns the hall of the Highland Society. Acquired for Poltalloch, Duntroon appeared the following year at the head of the aged males at the Battersea International Exhibition. Duntroon along with two bulls, also from Perthshire—Glenlyon (290) and Crinan of Poltalloch (124)—proved of great value in the noted Argyll fold. A great stock bull, also in Mr. Malcolm's possession, was Fear-a-Bhaile of Ormaig (204), which introduced Monachyle and Duntulm blood with striking effect. Crinan, a big, level, kindly yellow bred by Mr. John M'Laren, Monzie, was one of the best sires ever used at Poltalloch. As a five-year-old, he won at Kelso; and in the younger class of heifers Mr. Malcolm took first place with Molachag, a magnificent red of Taymouth breeding and by Duntroon. Molachag held on her victorious course although she had formidable opposition at Glasgow in 1867 from the Atholl Proiseag Odhar, and her own fold companion Mhaigdean I. (530), which improved immensely and led the Aberdeen class a year later. Harking back to the Kelso Highland Show of 1863, the Duke of Athole then took firsts with three Breadalbane-

bred animals of altogether superlative merit. These were the bull Donull Ruadh, already referred to, the cow Rosie I. (33) by Donull Odhar, and the three-year-old Queen I. by the same sire and member of a strain highly esteemed at Taymouth. At Old Blair, Donull Ruadh's greatest son was the red Fear-a Bhaile (199), one of the most magnificent show animals of the race ever seen in a ring. He was out of the picturesque yellow Lili, a daughter of Donull Odhar. As an aged bull he passed his days in the possession of the Earl of Seafield, and left a large number of front rank animals. In course of the sixties of the century two exhibitors came almost at a rush into leading position, so far as prize-winning was concerned. Those were Mr. John Stewart, Duntulm, and Mr. Robert Peter, Urlar, Aberfeldy. Mr. Stewart's most famous animal at that time to the mere show-goer was the noble-looking Targeal Riabhach (799), a daughter of the admirable stock bull Lord Macdonald (345). Mr. Peter, the respected local bank agent, was a tasteful Highlander, and his cattle, which were somewhat closely allied to Chesthill and Taymouth strains of blood, were an ornament to the Aberfeldy district for many years.

Of the full thirty years specially under review as a showing period, the seventies were perhaps the most remarkable for the large total of superb animals placed before the judges. Fear-a-Bhaile of Atholl, shown from Castle Grant; the Duntulm brindle Sgiathanach Og (491); An-T-Eilanach (12), and Prionna Tearlach II. (427), by the West County Rob Roy (440); Mr. John Malcolm's Duntulm Og (182); the Duke of Athole's Duntulm-bred Sgiathanach (489) and his great brindle son Calum Riabhach (82), sire of Rossie and Calum Odhar, and grandsire of Calum Riabhach II., the "maker," along with the Ensay Ceatharnach Buidhe, of the Kinnaird Castle reputation; and Mr. James Duncan's light dun of Bochastle breeding, Donnacha Ban Nan Oran (155), came before the public during those years. Among the females were the Duke of Athole's Young Queen, a daughter of Queen I., and his pretty yellow Buidheag; Mr. Malcolm's splendid dun heifer Bealach (469), by Crinan, out of Mhaigdean; the Bochastle N'Odhar, grand-dam of the noted Proiseag Dubh (783), which through a couple of "Victor" sons—especially Victor V.—had such a powerful impression on Ardtornish; and the astonishing succession from Duntulm—Targeal Beag (797), Ribhinn Lurach (1304) (grand-dam of Ceatharnach Buidhe), and Guanach III. (789). Sgiathanach, afterwards the property of Mr. Duncan Macdiarmid, Camusericht, was a good-sized, short-legged, handsomely proportioned brindle. At Old Blair he left a magnificent lot of females, the most perfect of which was the red Rosie III. (34), which finished her show career by heading the cows at the Centenary Exhibition in 1884. The breeding of Sgiathanach is not given in the Herd Book, but Mr. D. A. Stewart states that the bull was by Ludan Og (346) and out of Donnach Faidach by Lord Macdonald (345), grand-dam Donnach Dubh by the Monachyle Broken Horn. Sgiathanach was strongly inbred to Monachyle blood, as the dams of Ludan Og and Lord Macdonald were by Broken Horn. Of the other bulls referred to, Donnacha Ban, which had the "Nan Oran" added after he left Bochastle in honour of the Celtic genius Duncan Ban M'Intyre, might be classed as about the best from the breeding viewpoint. To look at, his face appeared to be his fortune, for he was if anything rather high standing. Still, he left a large nnmber of beautiful true-breeding females which commanded the attention of the best judges at Benmore, Poltalloch, and Ardtornish, the Benmore cattle having been taken over in a body by Mr. Valentine Smith in 1887. Calum Riabhach, who ended his days

at Poltalloch, was a noble-looking Highlander of the old Taymouth model—majestic in outlook, massive in frame and bone, rich in hair, but rather thick in neck. As a breeder Ribhinn Lurach was perhaps the most distinguished of the three females noted together as from Duntulm.

Coming down a decade, Mr. Duncan Macdiarmid's very prettily built, low-standing, Athole-bred Ailpean (4), the Corrychrone-bred Rob Roy III. (442), and the Duke of Athole's Calum Odhar (79) and Rossie (456) by Calum Riabhach, were perhaps the most notable males, and of the four the most picturesque in a "wild headed" sort of way was Rob Roy III. He was in several folds during his long career, but he was an inexplicable disappointment in a sense. His sire was the very fine bull Duke of Athole (581), a son of Sgiathanach, out of Jessie of Taymouth, by Donull Ruadh, and his dam was the Bochastle descended Dubh Mholach by Glentilt (295)—a son of Donull Ruadh, out of the Taymouth Rosie. The late Mr. John Stewart, Bochastle, used to say that he did place much reliance on the dam of Rob Roy as a breeder. Through a grandson—Victor (828), used with admirable effect in the early career of the Ardtornish fold—Rob Roy III. came well if somewhat belated into his kingdom.

Since those days of the eighties and early nineties of the past century, a good many tenant-farmers have dropped out of the Highland ranks, and it is consequently much more difficult to find stock bulls like Rossie and Ceatharnach Buidhe. Some good judges also declare that females to match Rosie III., Proiseag Dubh Mairi Bhuidhe (2321), Te Bhuidhe (1379), and Laochag Bhuidhe IV. (6584), are not likely to appear far on in the twentieth century, but such a view is of too despairing an order. It is rather singular, however, that many modern show representatives of the breed are faulty in the bygone strong Highland points—quarters and hind legs. The breed has not been receiving a fair measure of justice of late years in some parts of the Highlands. Grazings have been allowed to become worn out or stale, or have been run into a soiled condition through ground game. At the same time winter feeding and shelter have not been attended to in a thoroughly practical way.

A great impulse was given to the breed in many ways by the forming of a Registration Society in 1884. The late Earl of Dunmore, who had done exceptional work on behalf of shorthorns and Clydesdales, took a leading part in forming the "Highland Cattle Society of Scotland." At an enthusiastic meeting held in the Edinburgh Centenary Showyard, the Society was founded without the least difficulty, and the first volume of the Herd Book, containing the pedigrees of 561 bulls, along with notes on the history of the breed and scale of points, was issued in 1885. The points of the Highland breed have not been appreciably modified in recent years. Many judges, however, who began life with Taymouth and related strains, have now to content themselves with animals of rather less scale. The more generally popular style of horn in a female takes an out, slightly forward and upward curve, but a fold should have specimens of the out, forward, and back swirl. The horns should be wide apart at the roots, and show mellowness and "sap" to the points. A clear, hard, "shiny" horn is apt to be associated with slow feeding qualities. Black-tipped horns are not, strictly speaking, fairly allowable except in black and dun animals. In the case of a brindle it is certainly a strong recommendation to have a waxy yellow tinge right out to the end of the horns. The brow should be wide and covered as much as possible with long hair quite free from curl. From eye to nose the face should be short, and the nose itself should be somewhat broad, indicating breathing space and

strength of jaw. Other points are distinctly good as judged by a severe standard which has the finest shorthorn in view. The side survey of the perfect Highlander presents a rare picture of straightness, depth, balance, "life," and distinction, on short, strong, straight legs. It is to be regretted that the almost perpendicular drop from tail-plate to hock point and heel which Bates admired in other days is now too seldom seen. Old judges liked mature female animals to be very wide across the hook bones; but modern men, while looking for plenty of width, do not take kindly to prominent hooks, as such a feature is prone to be accompanied by bare loins. Plenty of bone is desirable in a Highlander, but it ought to be flat and mellow. Mere "posty" bones are a handicap for meat or milk.

In a bull a wide sweep of horn quite free from down-curve and with very little up-curve at full maturity is best. Fair breadth across the crops, as much spring as possible in fore-ribs—flat-sidedness being an old fault of the breed—well-turned and covered hooks, strong fore-arms, deep thighs and flanks, broad hock joints, good-sized hoofs, and alert springy carriage are looked for in a well-bred male animal.

Hair is one of the all-important features of the breed. Towards the fall of the year the genuine Highlander has a coat and vest—a long outer covering specially prominent on brow, lower edge of ear, ridge of neck, then fairly plentiful on the rest of the upper line, and abundant down the thighs. The under coat or vest, which is shed more or less at outgoing of spring, is soft and thickly planted. The outer coat should always be of fair strength, but free from harshness and dryness. It is easier, as a rule, to secure this strength in the darker animals than in the soft light yellows. The hide should always be thick, but mellow and pliable. In a preceding paragraph reference was made to the great sweep of horn in the old Taymouth cattle and to the minor fault of extra length and strength below the eye. These characteristics are perfectly exhibited in the Atholl Te Riabhach (35), whose likeness is given in volume iv. of the Herd Book.

Dock ears are a long-founded and persistent peculiarity in the Highland breed. The old Perthshire tradition was that the defect had its origin during the ear-making times of the sixteenth or seventeenth century —the off-set being the result of natural shock. The theory is plausible. Strains of Forfarshire and Perthshire black cattle had also forms of dock-ear a generation ago. Let the origin be attributed to shock or "sport," it was probably strongly implanted by in-breeding.

Management is simple in a sense. Yeld stock intended for breeding thrive best when always in the open and with the option of a plain shed to step into for a bite of hay during a winter storm. A few turnips in winter are aids to growth. It is desirable to tie up the cows before the calving or to put them into separate boxes, as it tends to disarm their suspicions, and also allows full opportunity for handling the young things, which thus never become really wild even when set out to the hillside. Good managers try to avoid sending late calves to hill or moor. They keep them, if at all possible, near the farm buildings until mothers and young feel at ease. It is undesirable to breed from high-strung strains of females, which are apt to become very excited at drop of calving. Newly weaned calves must be kept going on fresh pasture, and the udders of the cows still giving milk must be hand-stripped if they are to do well the following season. Bulls are easily trained to lead as a rule, as they are very intelligent. On parade they occasionally supply a little deep-sounding "music," but no actual harm is intended. A sensible, placid-tempered bull has a wonderful influence for good on a breeding fold.

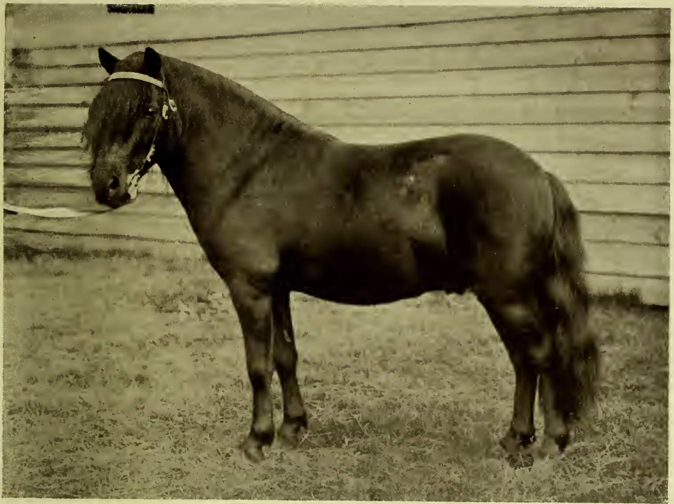
The breed has gained something like a year in early maturity since the sixties of the past century. Many tenant-farmers now consider the old standard time of four years too late by twelve months for first calving. They contend with force that if some size is sacrificed by calving at three years, milking is improved and the females tend to make more regular breeders. At one time special strains of the breed were fairly heavy milkers. Quantity has been allowed to fall away in many cases, but quality is still of an exceedingly high order, and the females are the grandest of nurses.

With plain, clean keep during the early stages of life, and a share of concentrated foods from the six-quarter-old period onwards, well-bred steers and heifers make good use of their time, and at the great fat stock exhibitions they prove an immense attraction. Then sales of Highlanders are among the first to be struck, as the distinguished looking heads, heavy hides, and superb quality of beef form a strong combination. At the 1907 Smithfield Show the younger steers averaged 12 cwt. 62 lb. live weight at practically thirty-two months; the older steers, 16 cwt. 20 lb. at forty-four months; and the heifers a fraction over 13 cwt. at about the same age.

Volume xiv. of the Herd Book contains the pedigrees of bulls up to 2217 and of female animals up to 7142. Specimens of the breed have been exported at various times to North and South America, Manitoba, and the Canadian North-West, Australia, New Zealand, Russia, and one or two other countries, but up to the present time (1908) outside demand has been meagre. Trysts such as those of Falkirk and Doune for sales of commercial stocks will soon be no more than a memory. They have been killed by Auction Marts. Since 1892 increasingly successful spring sales of bulls have been held under the auspices of the Society, first at Oban, then at Perth and Inverness, but since 1895 continuously at Oban, which is now further recognised as the official centre for autumn joint disposals of breeding stock. Highland heifers cross admirably with shorthorn, Hereford, and Aberdeen-Angus bulls, and it is held by many that this department of the breeder's business might be further developed, especially on the secondary old grass lands of England. Mr. Duncan Shaw, Secretary of the Highland Cattle Society, states that the membership of his organisation in Great Britain and Ireland is 186. Two members are resident abroad—one in Canada, the other in New York.

Highland and other Ponies.—A definition of sufficient accuracy and workable flexibility for the term "pony" has still to be found. The Shetlander has been classed as a miniature Clydesdale of an old-fashioned order, while the characteristic pony of Wales has been hit off as a model hunter in small compass. In the eyes of many a pony is merely a much compressed pattern of a horse. That easy system of classification does not satisfy genuine lovers of ponies. Such individuals maintain that the pony has a character of its own—difficult to define no doubt, but still easily distinguished. Their favourite is a "bantam horse"—and much more than that. Of the distinct breeds or races of ponies it is thus true that they are not mere copies of their larger-sized equine relatives. Time, blood components, and systems of feeding and handling have resulted in differentiations within the pony sphere, and such surface by-plays on a simple or complex groundwork have not in every essential paid respect to what has been transpiring in the life-history of the larger breeds of horses.

It is practically impossible to give the number of varieties within the



Reid.

SHETLAND PONY STALLION.

Reid.

HIGHLAND GARRON MARE.

old families of ponies found in the United Kingdom. The classifying and numbering task has not been rendered much easier in modern times. For the sake of convenience, pleasure, and profit, certain breeds or races of ponies have been evolved, mainly within themselves, and subjected to definite rules and scales for the purpose of ensuring bold individuality and as large a measure as possible of uniformity. There is now a general agreement that the maximum height at the shoulder for an animal of the pony order should not exceed 14.2 hands, a standard which is aimed at in the registered Highland garron, and the modern composite, the polo animal. The low limit has been left to take care of itself, which may be reckoned a wise arrangement. A height of 8 to 8.2 hands is not so very difficult to obtain in a Shetlander, but in practice it is not easy to secure a sufficient amount of power for saddle and harness purposes under 9 hands.

The principal distinct breeds of ponies in the United Kingdom are the Shetland, Highland, Cumberland and Westmoreland, Welsh, New Forest, Exmoor, Dartmoor, and Connemara. Of these the purest and most characteristic is the Shetland. Other breeds of ponies have been more or less subjects of experimental crossing, but the Shetlander has probably remained uncontaminated for hundreds of years. From a figure on the "Bressay Stone" it is assumed that the small breed of ponies was to be found on the islands prior to the Norwegian invasion of 872 A.D. It was wont to be conjectured that Scandinavian invaders introduced foundation stock of ponies to Shetland between 1300 and 1400, but there are stronger grounds for the belief that the ponies were "ferried over" from the Scottish mainland. Mr. James Goudie takes that view in his introductory essay, published in the first volume of the Shetland Pony Stud Book. Brand, who visited the Shetland and Orkney Isles in 1700, was the first to give a relatively complete description of the "Sheltie." At that time the Shetland ponies usually measured from 9 to 10 hands, and any animals up to 11 hands were considered big. Summer and winter the little animals ran "upon the mountains, in some places in flocks," and when straitened for food in winter they came down to eat the seaware.

Long before Brand's time, in 1612, a special statute was passed by the Court sitting at Scalloway to prevent use of "uther men's horsis and stowing of thair tailles" without permission from the owners. It was decreed that "quhasoever sall be apprehendit ryding ane uther manis hors without licence and leave of the awner inwith the parochin quhair the awner of the hors duellis sall pay to the King's Shirref or deput four merks and to the partie awner iiij marks." The native pony is still a "horse" to the older race of Shetlanders. In 1700 black was the favourite colour, the "pyeds" or piebalds being accounted less durable.

A quarter of a century before the issuing of the first volume of the Shetland Pony Stud Book (1891), the breed was in some danger. Its good qualities as saddle and harness animal for children had been recognised in England and Scotland previous to 1850, but about that time, according to Mr. Robert Brydon, it began to be much appreciated for haulage purposes in the north of England coal pits. In the early seventies of the past century the Marquis of Londonderry acquired Bressay grazing, and immediately began to found a stud with the best animals which he could purchase in the islands. For twenty-five years the work of improvement continued in a most vigorous and enlightened manner, and it is not too much to say that every stud of the breed to-day is deeply indebted to Seaham animals. The Londonderry aim was to breed the greatest possible amount of power on short active legs.

A generation ago a good many of the Shetland ponies had rather big "horse-like" heads, and some of them were just long enough in the coupling and over-set on their hind legs. These faults have been almost completely bred out. The genuine pony head with its bright yet pawky intelligence, the strong coupling, level quarters, great arms and thighs, beautifully set legs, clean points, tough shapely feet, and free action are in the ascendency. A minority would like to encourage the old-fashioned "cobby" type now referred to, and find room at the same time for the more narrowly got-up and "genteel" 36 to 38-inch animals which are assumed to be more suitable for saddle. So far the thick-set, short-legged type easily holds the lead in price. Shetlanders are passing from the underground sphere of usefulness, but they are daily extending their dominion at home and abroad as children's companions, bearers, and friends. They have a great future in North and South America. Although chestnut, light bay, or form of grey, dun, and piebald are still to be seen in the Shetland ranks, the breed is fast settling down to the whole black and brown standards.

Professor Cossar Ewart likes to think of a "Celtic" type of pony. The term has its convenience for purposes of classification, but the origin of the breeds or clans of ponies which have been traced back and lost in the lands of the Celts, is meanwhile a matter of pure conjecture. As already noted, there is good ground for holding that the Shetland pony is racially akin to the old Scottish mainland breed which was fairly plentiful from Stirling to Sutherland down to the middle of the past century. That breed again appeared to be related to the ponies of Mull, Tiree, Skye, and Uist. It is difficult to give a date foundation for the term garron (or gelding), under which the old native pony or horse of the Highlands came to be distinguished. The probability is that the term gained power as the proportion of geldings or work animals increased, until even "n'stallan" (the stallion) had to come under its sway. In these registering days the Highland pony or garron is standardised for height at 14 to 14.2 hands, but over forty years ago Perthshire had the remnant of a breed identical in character with the smaller race, and measuring up to 15.2 hands. Whether these were the result of selection from within the old ranks or of crossing with troop horses, as Mr. Munro Mackenzie suggests, is a debatable question. The likelihood is that the larger strain had its offset from an outcross, and that character was maintained by breeding back to the old blood.

Vigorous efforts on behalf of the old Highland breed of ponies have been put forth by the Dukes of Athole and their tenants, also by the holders of Gaick Forest and grazings in Lochaber, Guisachan, Aldourie, Glengarry, Applecross, Glenorchy, and other sections of the Highlands. The Athole stud of Highland ponies is supposed by some to have been founded in the sixteenth century, but an approximate foundation date is a matter of pure guesswork. The late Duke George was the first of his line to give special attention to the improvement of the home stud of riding and deer-stalking ponies, and the stock of the same breed held by his glen and upland tenants. A popular stallion set on the road by the Duke was a beautiful cream-coloured animal led by a faithful retainer whom old Athole men will remember well under the name of Uilleam Bann. A piebald some time "in residence" was no doubt foaled earlier than the cream. The latter takes one back to the late fifties and early sixties of the past century. Glentilt, a Glengarry bred grey, succeeded the "Stallan Buidhe" (yellow stallion) at Old Blair, and in most respects he was the truer of the two in what good judges classed as Highland character. Smaller ponies than those deer-stalking and general purpose animals were at one time common all over

the counties of Perth, Argyll, Inverness, and Ross. Most of them were short-headed, cobbily-built, and wonderfully powerful 12 to 13 hands beasts, very durable, and of great usefulness for saddle purposes. Dark colours without white marking, dun and grey, were esteemed, just as in the garron.

It is to be regretted that the island of Mull, once the home of a very fine variety of the Highland pony, has partly by neglect, partly by expatriation of the best, and considerably by crossing and experiment, lost a strain which might be of great use to-day. Other parts of the West, except a section of Uist, have mongrelised the Highland pony septs to a very large extent. The difficulty practically everywhere now is to secure a strain which can be guaranteed to have an unbroken line of purity. The typical old-fashioned 14 to 14.2 hands Highland pony or garron had a bright, intelligent, almost Arab-like head, fair reach of neck, good trotting shoulders, something of a quick dip behind the withers, excellent quarters, clean, sinewy legs, and the best of feet. In walking it had a form of jaunty "toss" or swing, the tail being thrown from thigh to thigh.

The pure Galloway pony may be assumed to be extinct. Faint copies of the old pattern are to be found in or at the border of the Clydesdale world, while animals much akin in foundation blood pass under the name of Cumberland and Westmoreland ponies. About the middle of the past century, according to old Cumbrians, the ponies of the Fells were a somewhat mixed lot with partial suggestions of the Shetlander running through the Galloway. Certain strains, however, much after the Galloway type, had been bred pure for generations. These were greatly esteemed as saddle and pack animals when bridle-paths were more plentiful than roads. The "Wilson Pony" of Westmoreland is by far the most brilliant offset from the native stock. Animals of the Fell type are compact, cobby in build, with riding shoulders and great bone below the knee. They are usually from 13.2 to 14 hands, and the prevailing colours are black, brown, and bay. Action, toughness, and hardiness are their prevailing characteristics.

When Wales had great extent of common lands, its mountain ponies had ample feeding range, but the Principality continues to favour its old native races of the pony and cob order in these days when commons are being enclosed and when shepherds like to reserve the best tracts for their flocks. The origin of the Welsh pony is unknown. It is not certain as to whether outside blood was introduced previous to the eighteenth century, but in the early decades of that era the remarkable little thoroughbred stallion Merlin was turned out on the hills and effected a marked improvement, so far at least as selling value of produce was concerned. At the end of the eighteenth century there were great complaints in certain parts of Wales regarding the increase of the smallest breed of ponies and to the trespassing and mischievous habits of such animals. One writer in the *Gentleman's Magazine* urged that an Act of Parliament should be passed for the purpose of excluding horses under 14 hands from the common grazings. Hackney blood was introduced into Brecon at Cardigan through such sires as Fireaway, Comet, and Alonzo the Brave, and the result was a great increase in saleable cobs and ponies. Since 1902 the Welsh Pony and Cob Society has taken up the work of improvement on right lines by classifying and registering stock in four divisions—(*a*) The pure Welsh pony not exceeding 12 hands; (*b*) ponies from 12.2 to 13.2 hands, with a cob cross direct from the Welsh pony; (*c*) ponies of 13.2 to 14.2 hands, with a stronger infusion of cob blood; (*d*) Welsh cobs of 14.2 to 15.2

hands. The North Wales 12 to 12.2 pony has "pony character" and active hunter action. In the South Wales animal of practically the same height the conformation, especially in hindquarters and hocks, might be considerably improved. Bay and brown are the favourite colours.

An attempt has been made by Mr. Moens to trace the New Forest pony back to a native race which ran wild on the Hampshire commons and moors before the eleventh century. The New Forest ponies were certainly numerous in the thirteenth century, and they were probably kept practically free from alien blood during the reigns of John and Henry III. In comparatively modern times a notable outcross was introduced through the small pony-like thoroughbred stallion Marske, which was acquired at a trifling sum in 1765 by a Dorsetshire farmer from the Duke of Cumberland's heirs. For four years mares from the New Forest were served by Marske, but when Eclipse acquired renown as a racer, a search was made for his sire, and little Marske was shifted into Yorkshire when about twenty years old.

During the early decades of the past century, the New Forest ponies were allowed to degenerate. The best were sold, and far too little care was exercised in selection of stallions to run with the mares. Arab blood was introduced with considerable effect, so far as good looks were concerned, by the late Prince Consort, and at a later stage by Queen Victoria, but the most effective outcross by far has been supplied in course of the past twenty years by Lord Arthur Cecil, through the medium of the old Rum breed of ponies. In Lord Arthur's opinion a smart Welsh pony stallion of 13 to 13.2 hands might have followed the Rum cross. Exmoor blood has been introduced since 1898 with very good effect, and the New Forest Association is now looking well after the interests of the breed. As the ponies have been subjected to so many experimental outcrosses, they are meanwhile somewhat varied in character, and their colours range from white and grey to black, while the height runs from about 12 to 13.2 hands.

Exmoor and Dartmoor ponies may be considered together. Ponies have run in a practically wild state on those moors for hundreds of years. When pack horses were required there was a "rounding up" of moor ponies, and the stoutest were selected for training. Exmoor came to the parting of the ways in 1812, when fully 10,000 acres of its total extent were judged to be the property of the Crown. Mr. John Knight acquired the Crown allotment in 1820, and to that he added a section held by the Acland family. To these he again added the adjoining Brendon property. Mr. Knight started crossing experiments through Dongola Arabs, and he followed up with the small thoroughbreds Pandarus and Canopus. Various experiments have been made since that time with the object of partially breeding back to the older type. With the exception of the "Acland" ponies, probably all the latter day Exmoors are of mixed blood. The October fair at Bampton is the principal exposing stance for the ponies.

Dartmoors of the smaller strains have been used to some extent for crossing with Exmoors, and mares of the combination have again been put to the most compact little thoroughbred and Arab stallions available. The names of Mr. Willing and Mr. Wooton are the best known in connection with those experiments. Nearly thirty years ago an interesting series of experiments with a son of Mr. Christopher Wilson's Sir George came off very successfully. Size was reduced and the game-like character was strongly upheld. The typical Exmoor pony of these

days should average about 12 hands and have thorough pony character. Dark bays and browns with black points and "mealy" noses are the colour preferences. Dartmoors are in most respects similar in points to the North Wales breed. The maximum height for a stallion is officially put as 14 hands, but very few animals of the breed exceed 13 hands.

For centuries Ireland has had its breed of stout ponies or "hobbies." Whether the foundation strains were from Scandinavia or Spain is uncertain. The so-called Connemara breed of ponies of which so much has been heard periodically since the middle of the past century, is far from being a race stamped with fair uniformity of character. In his report on "the Ponies of Connemara" (1900), Professor Cossar Ewart was rather bewildered by the differences in size, colour, character, and his view was that the race contained five types. According to Mr. Ussher Roberts, C.B., Barb or Arab blood had been introduced into the Galway district during the thirties of the past century by the Martin family, but the handsome shapes and more or less blood-like appearance of the descendants of the highly-bred stallions were not allowed their full and fair opportunity as development agencies. Poverty forced many owners to sell the finest mares or to discard ponies altogether in favour of asses. At the present time the Connemara pony, which has been standardised for registration, averages from 13 to 14 hands. It is a long, low, stoutly-built animal, generally yellow-dun, grey, or brown in colour. The head is too large if anything to please some British breeders of ponies, but the ears are small and pointed. The quarters are also slightly drooping or rounded. Plain bits such as those noted show that the Arab or Barb element has been practically worked out.

Ponies of the Iceland, Faroe, and Fetlar breeds are of less importance, historically and commercially, than those to which detailed reference has been made. "Made-up" breeds, such as the hackney bantams, the offsets from the Cumberland and Westmoreland and Welsh stock, and polo animals, do not fall naturally within the scope of an article on ponies. The polo mount is of considerable importance as a saleable animal, but its right to the title of "pony" is doubtful.

Hoes.—Hoeing is performed with two objects—the destruction of weeds, and the loosening of the surface to form a mulching so that the evaporation of moisture may be better controlled. When corn realised high prices the hoeing of corn was much more practised than during the last quarter of century, when prices have been low; this perhaps is more the case in respect to hand-hoeing than horse-hoeing. Successful horse-hoeing is largely dependent upon the accuracy of the drilling, as unless the rows are exactly parallel the rows where the draughts join are liable to be cut up; it is for want of greater accuracy in drilling that more horse-hoeing is not performed. This points to the need for drills with steerage easy to control, and the horse-hoes easy to steer. Opinions differ as to the value of horse-hoeing corn crops, some contending that lateral roots are destroyed to the prejudice of the plant, while others believe that this is the case only when unsuitable hoes are used, or when the drilling is inexact. On land that has a tendency to set hard in spring there is no doubt that the horse-hoe affords the best means of breaking the cap; and as a hard cap places the crop in a prejudicial position should a period of hot or dry weather set in, it is essential that the cap be broken, otherwise the soil moisture is readily drawn out of the ground because the capilliary channels are

unbroken; loose soil retains this moisture to the benefit of the crop. The form of the blade is also important, for while a hoe of a V shape by running with horizontal edges breaks off little root, although working very close to the row, a hoe with the stem running down to a blade set at right angles, forming an L does give a vertical cut or tear which may seriously destroy the root. It has always appeared unaccountable to us why hoes other than those of a V or half V shape are used so generally as they are. A V hoe placed on a stem with a proper curve or pitch draws into the ground with very little pressure and with the under friction reduced to a minimum. An L hoe cannot enter the ground without great pressure unless it be exceptionally loose and friable, as its construction is such that it is difficult to conceive a form better suited to resist entry; and it is only by the application of much weight, causing great under friction, that hard ground can be entered by it. The effectiveness of the work is thus lessened and the draught greatly increased. It is possible that many have not realised that the loosening of the surface is so beneficial, and they only regard the one feature of scratching or cutting up the weeds. To cut the weeds with these blades they must be very sharp unless the weeds are young and tender, and the edges soon become blunt, and will not cut old weeds of plants like hog-weed (*Polygonum aviculare*). What has been said in respect to the two types of blade as affecting corn hoeing, holds to a considerable extent with root hoeing, though to a less degree when the plants are young, because roots are usually sown on loose tilths. A modification of the L hoe may be used to clear away young weeds from rows of young turnips or mangels, and in cases where there is a probability of smothering the young plants growing in a deep drill coulter mark, such a blade is specially useful. Blades of this type have a raised front, the edge nearest the row of plants being raised so that the soil is pared away from the plants and turned into the space between the rows. The result of this work, however, is not always so satisfactory as the cleaning effected might suggest; for this paring of the soil near the plants leaves the surface smooth, and unless quickly broken allows the moisture to escape by capillarity, leaving the roots of the young turnips deficiently supplied with moisture, so that they become stunted and rendered more liable to succumb to the attacks of the "fly" or other insect. When weeds are cut by the wing of a V hoe working under the ground, the soil is not left in this condition, but loose, so that the moisture is retained about the roots of the young turnips, which thus grow more speedily out of danger. A man guiding a horse-hoe with the wings of the hoe under the soil soon learns to know to a nicety how wide they are cutting, and can steer quite closely to the row without danger of cutting up the young plants. It is desirable to emphasise the liability to the hindrance of growth which is occasioned by leaving the land scraped smooth about young turnips, etc., when hoeing, horse-hoeing, or singling the crop, and even at a later period, because a large proportion of the root crop suffers very materially from every hot summer; therefore, the working of hoes should be directed to avoid this. It is more important in the hotter parts of England than in the north or in Scotland, but dry weather is dangerous anywhere if the moisture is not conserved about the roots of young plants. V hoe blades have generally been much improved in recent years by giving them a somewhat convex top, so that there is no friction on the under-side except just at the edges; hoes which are flat should be rejected.

The steerage horse-hoe is the most effective of the horse-hoes for both deep and shallow work; it is easy to steer, can be made to enter the land to any

required depth, is well suited to work on hard land, but is somewhat heavy for the man to lift out and carry round at the ends of the rows, though most of these hoes are now made with levers to raise and carry them; the chief disadvantage to them is that the control of these hoes has so much to be done by the holder direct without mechanical aid. Blades of all sizes, even up to 2 feet in width for hoeing practically all the ground between the drill rows of roots, down to 3-inch spud points for hoeing barley, can be attached to the frame; and any arrangement of the hoes can be made to suit the purpose for which they are intended. Moreover, it can be used as a deep tiller, and with large hoes be used to cut thistles at the depth to which the land is ploughed, often desirable when a tilth or seed-bed has been a long time in preparation, and reploughing is not desirable. The frame can be made to carry moulding breasts for ridging up land, two or three at a time, according to the size of the frame.

The lever hoe is probably used more than any other horse-hoe for hoeing corn, and much of its popularity is probably due to the small amount of labour necessary from the man working it, as convenient attachments render the steerage and lifting easy. The hoes are attached to long coulter arms, which are hinged to a bar in the front part of the frame; while depth of hoeing is controlled by weights placed at the back end of the coulter arms; being capable of rising and falling, they possess the advantage of dropping into inequalities of the surface which the rigid framed steerage hoes cannot. It is, however, essentially a shallow worker.

Single-row hoes are for the most part small grubbers carrying broad-shares or stirring tines, and are chiefly used to work between rows of roots, beans, or potatoes. Some of the hoes are made with rigid frames requiring the hoes to be separately adjusted to the width of the rows; while others have expanding frames which widen and narrow as desired to suit the work. Much work done by single-row hoes can be done with multiple-row hoes; though where exceptional stirring is desired they are most effective.

Planet hoes, where the principle of the sickle-tine hoe is much utilised, are exceedingly effective, and for many purposes of single-row work are the most useful of the smaller implements. They are made with expanding frames, and derive much of their value from the ingeniously designed blades with which they are fitted. Like other single-row hoes, they are more strictly grubbers, though with some of their attachments they are effective hoes. There is scarcely any tillage purpose to which they cannot be effectively put; and they work effectively and economically. They are supplied for horse and manual work.

Sickle-tine hoes.—Cultivators in which the sickle-tine principle is used have come into use during recent years, and these are readily converted into horse-hoes, performing good work.

Hand-hoes.—Although simple in construction, hoes vary considerably in different districts, traditional use seeming to control the preference for one form over others. There can, however, be no doubt that for general purposes a blade with a full swan neck to attach it to the handle is the best. In many districts, however, labourers are not accustomed to a long stroke, and can only use a hoe as a chopper. A good hoer can pull through a stroke of 5 feet or 6 feet with ease, and to do this he requires a hoe with a sufficiently long and open neck not to block as he draws it. On very heavy land there is an excuse for using more adze-like hoes or mattocks for some kinds of work, as a heavy tool which will chop through hard soil may be necessary, and also on flinty or brashy soils where stones obstruct or

divert the stroke, a shorter is necessary; but with these exceptions other than the single swan neck should be avoided.

Snatch-hoes are hand-hoes made by attaching two or more hoe blades to a head, making a sort of multiple hoe. On light fen soils a man will hoe 3 acres of spring corn a day. The method of using these is to walk backwards, pulling the hoe with snatches or jerks. On such land they do good work; but on hard or strong land they are not serviceable.

The Canterbury hoe is not strictly a hoe, but a pronged pecker with the prongs set at right angles to the handle, and is used for pecking out couch and other weeds among hops or during other cleaning operations.

Holly, The.—*Ilex aquifolium*, Linn. This well-known, well-loved tree belongs to the small order *Aquifoliaceæ* (Bentham; but *Ilicineæ* of some botanists), widely spread in both northern and southern hemispheres, but limited in the United Kingdom to a single species of one genus. It seldom exceds 30 feet in height in a wild state, but the cultivated varieties are innumerable, some of which grow to double that stature. Loudon recorded one at Claremont, in Surrey, 80 feet high. The wild type has evergreen *leaves*, shortly stalked, alternate, thick, shining, of a deep clear green, with undulated margins. Those on young plants are bordered with strong spines; as they are also on the lower parts of older plants and on plants treated to clipping; but so soon as the limit of the browsing line is past, the leaves become perfectly spineless and smooth, as if the tree knew that it no longer required that kind of protection. Some of the cultivated varieties bear spiny leaves at all heights; others none but smooth leaves. *Flowers*, consisting of a calyx of four, sometimes five, short segments, and a white corolla with a like number of petals; four, sometimes five, stamens, alternating with the petals, and a four-celled, sessile ovary crowned with four minute sessile stigmas, with a pendulous ovule in each cell. *Fruit*, a berry or small drupe, bright scarlet, sometimes yellow, more rarely black, and a white-berried variety is mentioned by old writers. Within the berry are four small nuts or stones enclosing the seeds. Botanists do not agree whether the holly is monœcious or diœcious. If, as is generally supposed, the perfect flowers are hermaphrodite, they occur very seldom. Darwin stated that, having examined many hollies during several years, he never found a single flower that was really hermaphrodite. They are nearly always imperfect and unisexual, consequently many trees never bear any berries. It is unfortunate that this cannot be detected in a young state, for the plants do not flower till they are several years old.

The holly has a wide range, extending from Western Europe to the Himalayas, but cannot stand the cold of North-eastern Europe and Northern Asia. It is indigenous in all parts of the United Kingdom except, probably, Caithness and the northern isles; and would be much more common than it is in our woodlands but for the plague of rabbits which has been allowed to spread over the country. These creatures are exceedingly fond of this tree, devouring seedlings and young plants, and gnawing round the bark even of aged trees.

The Welsh name for holly is *celyn* and the Gaelic *cuileann*, which are easily recognised as cognate with the English "holly" or "holm," formerly "holyn," retained in Lowland Scots as "hollen." Cullen, Cullenoch, and many other places in Scotland probably derive their names from the Celtic word, perhaps so does the English Colne; while Holmwood, Holmbury, etc., retain the alternative English form unchanged.

Probably "this incomparable tree," as Evelyn called it, is more generally cnown than any other in this country; thousands of children in great towns who could not distinguish between an oak and an ash are quite familiar with the beautiful evergreen which they have learnt to associate with the Christmas decoration of churches, shops, and dwelling-houses.

It thrives on many varieties of soil, preferring light or loamy land to ieavy clay, and relishing an admixture of lime in the staple. Economically the wood is of considerable value, being hard, heavy, tough, even and compact n texture. It is nearly as white as boxwood, which it much resembles, and when dyed black often passes for ebony in the handles of teapots. There is, however, no regular market for it in England, owing to the uncer-tain supply, the tree being of very slow growth. The plant is a favourite one for hedges, as it will stand any amount of clipping. The variegated and other cultivated varieties are propagated by budding, grafting, or from cuttings, but the ordinary type is easily increased by seed; which, as it lies a whole year in the soil before germinating, must be treated in the manner lescribed for the hawthorn (*q.v.*).

In planting out hollies, much depends upon the season selected. Small plants may be put out in April or May with best chance of growing away at once; but the end of May or beginning of June is the time of all others for moving anything over 3 feet and up to 10 or 15 feet in height. Much disappointment has been incurred, by following the advice of some writers on arboriculture, in planting or transplanting hollies in autumn, winter, or early spring. Large transplants at these seasons are apt to die off, and of the small plants a large proportion remain for years without making any growth at all. A liberal supply of well-rotted leaf-mould mixed with coarse sand should be mixed with the mould in planting, and the holly, being a gross feeder, responds generously at all ages to the stimulus of farm manure. Hollies grow well in towns where the atmosphere is not too much charged with solid carbon; but in London it thrives only in the large parks.

Homestead.—*See* Buildings.

Hoose—Husk—Hoast.—Verminous or parasitic bronchitis, known also as lung-worm sickness, is a non-contagious parasitic affection of the air passages of young calves under twelve months old, and recognised by a peculiar husky or faint rattling cough, which is due to irritation of the lining membrane of the windpipe (trachea) and bronchial tubes, caused by the presence of numerous thread-like worms (the *Strongylus micrurus*), whose natural habitat is the air passages of young calves; and although adult animals may be grazed on the same disease-producing pastures, they as a rule seldom become affected, the complaint being rarely seen in animals over twelve months old. The malady is readily produced by putting the young animals out to grass in the months of July, August, and September, on to strong, wet, undrained, or unsound grazing pastures, and leaving them out overnight or even after sundown, when the worms, the immediate cause of the trouble, by some means, on which there is a diversity of opinion, gain access to the body of the calf and locate them-selves in the bronchial tubes. These parasites, the *Strongylus micrurus*, are of the *Nematoda* or round-worm order, whitish in colour, and vary in length from 2 to 4 inches, and are about the thickness of an ordinary pin,

the female being much longer than the male. They are developed from eggs, and are ovoviviparous—that is to say, the small eggs are hatched inside the body of the parent worm in a manner similar to that of the viper. When under the microscope the impregnated worms have been seen to split open as it were, and the young embryos escape on to the slide, so that one impregnated female, which is estimated to contain some thousands of small eggs, on gaining access to the air passages is quite sufficient to account for the ready manner in which calves are attacked, and also for the enormous number of small worms found rolled up in balls and floating free in the frothy mucus of the bronchial tubes, as is seen on post-mortem examination. It is hardly possible, as is thought by some, that so many eggs could of themselves be taken up with the food into the stomach, enter the blood, and be carried by the circulation to the lungs, to be hatched in the short time it takes to affect the young animal, nor even to be inhaled; if either of these were so, then there would be no necessity for the parasites to be ovoviviparous. It is also quite evident that the parasites are nocturnal in their habits, as the calves may be grazed during the day on the unsound pastures—that is, after the dew is off the grass—and brought indoors again before sunset, and take no harm, but if left out overnight or even two or three hours after sundown they become affected, therefore the most feasible mode of infection seems to be that when the calves are lying on the ground with their heads stretched out, and in a drowsy condition, one or more impregnated female parasites crawl up the nostrils, over the larynx and into the windpipe, where the eggs are hatched inside its own body, and the young embryos liberated in thousands into the bronchial tubes wherein they grow, inducing the husky cough, by the means of which many of the worms are ejected on to the ground to undergo transformation, moulting, and fecundation, and to again repeat the cycle.

Symptoms.—The malady generally makes itself manifest in the late summer or early autumn months, and is greatly influenced by the state of the weather; if the summer be wet or muggy, the complaint makes its appearance early on, and is generally very rife; when, however, the weather has been fine and dry it is rarely seen. The first sign of the trouble is a slight husky cough, which may continue for some time without interfering with the general condition of the calf; but as the worms develop in size the irritation in the bronchial tubes increases, and the cough becomes more frequent, troublesome, and hacking, the animal begins to lose flesh, and, instead of grazing, stands by itself in a thoughtful, anxious attitude, with the back slightly arched, belly tucked up, coat staring, neck extended, nose poked out, eyes lustreless and dull, cough more aggravated, and when lying down the neck is stretched on the ground, and, if not speedily relieved, diarrhœa sets in, and death closes the scene.

Treatment.—As hoose has been known for ages past, the different modes of treatment have been legion. One old-fashioned remedy, which was considered to be very serviceable, is to give one to two wineglassfuls of lime water in the morning's milk and two teaspoonfuls of common salt in the evening meal; another being the administration of two tablespoonfuls of Stockholm tar every other day in a hornful of thin gruel, but one tablespoonful of turpentine mixed with one wineglassful of raw linseed oil and one pint of milk and given as a drench every other day is the most common remedy. (Note, turpentine should never be given in water.) Camphor and turpentine mixed, also assafœtida, have been tried, but seeing that the cause of hoose is the presence of worms in the air passages, the best and most effective mode of treatment is by fumigations of sulphur, chlorine,

or iodine fumes, or the injection of parasiticides direct into the windpipe, all of which come into direct contact with and destroy the pests. Fumigations are carried out by putting the affected animals into a close hull and allowing them to inhale the fumes, the handiest way being to put one or two of Seabury's sulphur candles into a pan and set it on a cask in the middle of the hull, lighting the candles and allowing them to burn for twenty or thirty minutes, keeping careful watch so that none of the weaker calves become suffocated. Roll sulphur may also be burned on hot coals in a pan. Chlorine fumes are liberated by pouring sulphuric acid either on a mixture of common salt and black oxide of manganese, or on to bleaching powder; but the most successful fumigation is obtained by placing a hot brick in a pail or pan, which must be put into the bottom of a loosely made sack, and then spread on the top of the brick half to one drachm of iodine, after which hold the head of each calf separately in the sack for five or ten minutes. All these fumigations are very exhaustive, and should only be repeated, when necessary, once every third day. Intratracheal injections are accomplished by making a slight incision through the skin over the windpipe, and with a hypodermic syringe the medical agents are injected into the windpipe, by passing the needle between two of the tracheal rings. There are various formulas for these injections, of which the following is one:—Turpentine two drachms, pure carbolic acid and chloroform each half a drachm, and almond oil one drachm, all mixed into an emulsion and injected as one dose about once every third day. This operation should be left to the professional man. Although these inhalations and injections annihilate the worms very quickly, their dead bodies still act as an irritant in the air passages and are either coughed up or decompose; it is therefore of the utmost importance that the strength of the animals be maintained by good, nutritious, and generous diet, such as boiled linseed jelly and milk; ground linseed cake, scalded, and mixed with milk or hay tea; or well-boiled oatmeal and barley flour gruels and milk; also small quantities of a mixture of crushed linseed cake, oats, and bran may be offered, while once each day to the linseed jelly and milk may be added two table-spoonfuls of cod-liver oil and a dessert-spoonful of common salt; the animals to be kept indoors in warm, comfortable, well-ventilated, dry loose boxes.

Prevention.—If there is one complaint more than another which is at all preventable, that of hoose in calves is the one, and yet in certain districts it is very prevalent. For years past it has been observed that when young animals have been kept indoors until they were twelve months old the malady was conspicuous by its absence, and in many cases they have been fed (and taken no harm) on the cut grass that has been grown on land which produced the complaint when the young stock were left out overnight or after sunset. In some places where the land is dry and sound, the calves may be turned out during the day and brought indoors at night, and do well. If calves are worth breeding, they should be worth rearing, and the best preventive for hoose is to keep and soil them in the house until they are over a year old. Boxes can readily be made with railway sleepers and corrugated iron roofs. If bedding be scarce, peat moss litter is very handy, and not only forms a good clean dry bed, but also absorbs the moisture and ammonia, and makes a grand manure, while various kinds of feeding stuffs for calf-rearing are offered freely on the market, so that those stockbreeders who have hoose amongst their calves have only themselves to blame. All the grazing pastures on which hoose has been known to prevail should be dressed with 5 to 6 cwt. of rough crushed rock-salt

to the acre, in the early part of March, every fourth or fifth year. If these conditions were complied with, hoose in calves would soon become a thing of the past.

Lambs are also at times affected with a somewhat analogous complaint, but in them it is seen in two forms—simple and complicated. The simple form or parasitic bronchitis or hoose is when the bronchial tubes are infested with small thread-like worms, the *Strongylus filaria.* The symptoms, conditions, and treatment are similar to those in the calf. The complicated form, *verminous bronchitis* and *diarrhœa*, or *paper skin*, is when the hoose is associated with diarrhœa or scour, which is due to still another parasite, the *Strongylus contortus*, infesting the lining membrane of the fourth or true stomach and bowels, producing great irritation accompanied by exhaustive diarrhœa, inducing the animals to drink large quantities of water; and as the disorder progresses they gradually dwindle away to skin and bone, the skin becoming tight and dry like parchment, hence the name "*paper skin.*" This complicated disease usually makes its appearance in September and subsequent autumn months, whilst moist muggy weather favours its production and development, particularly when the lambs have been grazing on unsound, wet pastures. Both the *Strongylus filaria*, the cause of the hoose, and the *Strongylus contortus*, the cause of the diarrhœa, like the *Strongylus micrurus*, which produces the hoose in calves, are ovoviviparous, so that if a lamb should pick up only one impregnated or fertilised female of each parasite, and each worm found its way to its distinctive natural habitat,—*i.e.* the lungs for the *filaria* and the stomach for the *contortus*,—and there deposited the embryos, ready hatched within their bodies, the lambs would soon be more or less affected, according to the number of embryos the parent worm deposited. It is thus a matter of importance to both buyers and sellers of lambs, and as the exchange mostly takes place in the later summer months, lambs in their transit from one place to another might readily be affected should they unfortunately be depastured, for only a few hours, on some disease-producing grazing ground.

Treatment.—For the parasites affecting the air passages in the lungs the fumigations and intratracheal injections as named for hoose in calves may be adopted, but for the stomach worms, when large numbers of animals are ailing, it is both laborious and troublesome to dose each animal separately; therefore a medicated food should be prepared by mixing equal parts of crushed oats, dried grains, bran, and sweet compound cake, and for each lamb calculate about half a pound of the mixed food, to which may be added ten grains of exsiccated iron and two drachms of common salt, or two ounces of iron and one and a half pounds of the salt to every one hundred lambs, and feeding them once a day. The branches of fir trees should be cut and placed on various parts of the pastures, and also large lumps of rock-salt as well, for the animals to eat and lick at their leisure. The disease-producing pastures ought to be dressed with crushed rock-salt, as recommended for those producing hoose in calves.

Hops.—The hop plant is the sole representative of the genus *Humulus*, and its only species, *H. lupulus*, is probably indigenous in this country, being frequently seen in hedgerows in districts where its cultivation is unknown. It belongs to the Natural Order Urticaceæ, and is therefore allied botanically to the Nettles, Hemp, and Wall-Pellitory. The cultivated hop must be regarded as merely a variety of *H. lupulus* of very old standing, and was introduced into this country in or about 1524 from Artois

(Pas de Calais), France. Its cultivation was not pushed until the early part of the seventeenth century, but about that period there were estimated to be about 12,000 acres of gardens. The number of varieties is very large, indicating similar powers of variation to what is observable in all cultivated plants. Professor John Percival contributed a learned article upon the English varieties to the Royal Agricultural Society in 1901. The strobile or fruit of the hop somewhat resembles a fir cone. These strobiles only occur on the female plants, and consist of a series of bracts (modified leaves) and bractlets (often called "petals"), arranged round an axis or "strig." On the seeds and on the bractlets, and to some extent on the seedless bracts, is found the lupulin glands of rich amber-yellow colour called "condition," and it is the character and amount of "condition" which determine the brewing value of the hops. Good hops should yield well; should be capable of hanging for a sufficient length of time; should be hardy and resistant to fungi and aphides; should possess a high lupulin content and a rich aroma. In the present state of the trade only the best quality of hops can be successfully marketed. They must be rich in lupulin and contain as little offal in the form of strig, petals, and seed as possible, and the petals must be thin, smooth, and of pale golden colour. The "density" or compactness of the hop, taken in connection with the shapeliness of the "petals," is the means used for distinguishing and classifying the different varieties.

Among the best early varieties are Bramling, White's Early, and Amos's Early Bird. Of mid-season or main crop varieties, Rodmersham or Mercer's, Cobb's, Canterbury White-Bine, Farnham White-Bine, Mathon White-Bine, Fuggles, Goldings, and Old Jones's. Of late varieties, grapes appear to include several allied sorts, Mayfield (grown in Hereford and Worcestershire) Bates's brewer, Bass, and Colegates may be mentioned.

The hop is diœcious, or carries the male and female flowers on separate plants, and it has generally been thought advisable to set a few male plants in the plantations. It is, however, not necessary, although opinion is divided on the subject. Some growers maintain that the fruit is denser or less loose in structure when male plants are present, while others look upon them as mere cumberers of the ground. Fertilisation is said to be insured by the presence of the necessary element in the female plants, which is scarcely consistent with a strictly diœcious character. Discussion on the point is frequent in gatherings of hop-growers, and various views are expressed which tend to show that the male plant is not absolutely necessary for the production of the fruit. How far it is necessary for fertilising the seed is not likely to enlist much attention in the case of a crop which is almost invariably raised from cuttings or bedded sets. The question in some respects resembles that of the effect of the male bird in egg-production, and the final answer belongs to the domain of physiology rather than of practical hop-growing.

The bitter principle of hops is an oily and resinous material, which not only imparts an agreeable flavour to beer, but assists materially in promoting its keeping properties. Even apart from the brewing industry, hops are valued for their tonic properties, and are the basis of Hop-bitters.

Pillows stuffed with hops have been recommended for sleeplessness and neuralgic affections. The value of the plant is chiefly concentrated in the fruit, but the bine is fibrous, and is in some countries used like hemp in the manufacture of coarse cloth.

It is also a valuable manure for oats and other crops, as will be easily understood by reference to the analysis of the bine and leaves given below. The English climate is exceptionally suitable for the production of hops of

the highest quality, and this alone ought to be a safeguard against foreign competition.

Of late years increased attention has been given to the propagation of improved varieties, and no class of agriculturists have shown a greater wish to profit by the assistance of scientific men.

Hop culture is restricted to a few counties in the southern part of England, and owing to severe foreign competition the area tends to diminish. The following Agricultural Returns published by the Board of Agriculture indicate the diminishing area:—

In 1877 there were	. . . . .	71,239	acres cultivated.
„ 1890 „	. . . . .	53,961	„ „
„ 1900 „	. . . . .	51,308	„ „
„ 1906 „	. . . . .	46,722	„ „
„ 1907 „	. . . . .	44,938	„ „

Complaints from hop-growers since 1906 have been urgent for some form of protection, and the present tendency is in the direction of abandoning the cultivation. Thousands of acres have been grubbed up, and the unsatisfactory state of the hop markets are certain to entail further reductions. And yet the climate of the more favoured parts of England is especially suitable for the crop, and English hops rival their competitors in quality, so that some growers favour the marking of foreign hops. Foreign competition affects hop-growers in an especial degree on account of new and improved facilities for keeping; and the two causes combined prevent those speculative rises and falls in prices, which at one time enabled growers to set one year against another.

The *Agricultural Gazette* of December 2, 1907, calls attention to this lamentable decline in the following words:—"Whatever may be thought as to the likelihood of obtaining such legislation as has been proposed within a reasonable time, it would certainly be an advantage if an inquiry were made into the whole subject, when it could be seen whether any measure could be adopted to arrest the decline of this important industry."

Taking the diminished area under hops during 1906 as a standard, the following were the counties and areas under hops during that year:—

Kent	29,296	acres.
Hereford	6,481	„
Sussex	4,379	„
Worcester	3,672	„
Hants	1,939	„
Surrey	777	„
Salop	127	„
Gloucester	49	„
Suffolk	2	„
	46,722[1]	„

The hop-growing counties form two groups, the one extending from the coasts of Kent, through Sussex and Surrey, into Hampshire; the other resting on the rich soils of Hereford, Worcester, and Gloucestershire. The cultivation is only possible upon deep, rich, naturally drained soils, and in such situations the duration of a garden has been known to exceed three hundred years. On soils less adapted for the purpose, the plants are short-lived,

[1] The same area as in 1826.

and the site requires to be shifted. The manurial requirements of the crop are the cause of heavy expense, and largely consist in nitrogenous dressings, such as woollen rags, sheeps' "trotters," blood manure, fish manure, dung, etc. Hops "are especially benefited by bulky nitrogenous manure" (Aikman); and the same author informs us that it is only when quick-acting manures are applied along with slowly-acting manures that they will exercise their full influence. In Warington's *Chemistry of the Farm* there is not a single reference to hops, and little attention has been bestowed on the chemistry of the crop by recent writers. Its extraordinary needs for the principal elements of fertility were, however, clearly shown by Way, who ascertained that an ordinary crop of hops removes from the soil—

	Nitrogen in lbs.	Phosphoric Acid in lbs.	Potash in lbs.
Hops	56·44	29·53	54·01
Leaves	49·00	40·61	57·15
Bine	23·86	15·51	22·81
	129·30	85·65	131·97

Comparing these figures with the requirements of a crop of 30 bushels of wheat per acre, we find that the latter in both straw and grain only removes 50 lb. of nitrogen, 21·1 lb. of phosphoric acid, and 28·8 lb. of potash. When we remember that hops are grown every year, and that wheat is only grown at intervals of years, it is not surprising that hops should require both rich and highly manured land. The following are approved dressings:—First year, 20 to 25 tons of good dung or 20 to 25 cwt. of crushed rape cake; second year, 15 to 20 cwt. of woollen rags, hair, shoddy, etc.; third year, 150 to 160 bushels of sheeps' hoofs, fish refuse, sprats, etc. The annual cost of manuring alone is stated to be about £7 per acre. As to yield per acre, it is very uncertain. One of the heaviest averages ever recorded was 13 cwt. 2 qrs. 2 lb. per acre (1808), and in the time of the duty the yield of hops was often made a sporting event. Glancing at the average yields per acre of hops, it is seen to vary from almost total failure to from 6 to 11 cwt. per acre. In the *Times* crop report for October 1907, Kent reported an average for the year of 6½ cwt., varying from 5½ to 10 cwt.; Sussex an average of 8¾ cwt., with variations of from 7½ to 10 cwt.; and Worcestershire and Herefordshire of 7½ to 8 cwt. One ton an acre has been grown in some cases, but a good average yield may be taken as about half a ton per acre. The price depends much upon quality. The preference for English hops is due to their combining colour, active, "fixed," bitter principle and strength, far above the hops of other climes (Whitehead). It is now the object of growers to produce hops of the finest character, and with this end in view the coarser varieties, such as Meopham's, Prolifics, Henham's, Jones's, grapes, etc., have been in a great measure discarded.

The price of hops has varied enormously at different periods. They have been known to touch £20 and even £23 per cwt., and to sink down to £2, 16s. and £3, 15s. per cwt. The average price for twenty-eight years after the repeal of the hop duties, ending 1889, was £6, 17s. 6d. per cwt., including the high average of £18, 10s. made in 1882. With such fluctuation as to both produce per acre and price per cwt., it is not surprising to

find that hop-growing has at times been exceedingly profitable and at other times extremely discouraging. One hundred pounds sterling per acre have often been realised, and in circumstances in which a grower has been fortunate in his crop, and also in securing a good price, it is difficult to name a figure which might not be reached. One ton is unquestionably a great crop, but the writer is assured that it is not at all impossible, and 20 cwt. at £10 per cwt. is easily reckoned. On the other hand, disastrous failures are not uncommon.

Hop cultivation.—Good land, a suitable climate, deep cultivation, liberal manuring, and thorough interculture are the principal points of land management. Hop cultivation entails so many operations connected with sets and settings, distance apart of hills, cutting crowns, training the bine, washing, sulphuring, picking, etc., that it is impossible to do justice to the subject within the limits of a few pages. It must be treated with the utmost brevity, while at the same time a general idea of the management and expenses will be laid before the reader. Only the best land should be selected, and this ought to be deeply dug with a three- or four-pronged spade. Farmyard dung, rags, sprats, shoddy, and other fertilisers are dug in at the same time. Bedded sets are always used, two to a hill, and are placed 6 feet 6 inches apart on the square, which gives 1210 hills to the acre. February and March are the best months for planting. When cut sets are used the land may be cropped between with potatoes the first year, but bedded sets will require short poles and will produce a little fruit the first year, and in their case no attempt should be made to grow anything but hops in the interspaces. Digging between the hills is necessary, and after the poles have been set up the ground is continuously worked with the large horse-hoes or nidgets, peculiar to the hop districts. Nidgetting destroys weeds and maintains a fine and well-aerated surface. The effect is a thoroughly cultivated staple of many inches in depth.

Much fewer poles are now used than formerly, on account of the newer system of training the bine upon wires and string made of cocoanut fibre, fastened to permanent uprights. This is preferable to poles, as the gardens are less liable to injury from wind. As the bines grow they are tied with rushes, and rank and forward bines are removed.

Hops require a great deal of attention during their growth, as they are subject to many attacks. Aphides are among the worst foes of the hop-grower. Hop-washing engines are used, and various washes are employed. One of the best consists of 7 to 9 lb. quassia chips, with 6 or 8 lb. of soft soap and 100 gallons of water. It is "a costly and tiresome process," as it entails the careful washing of every leaf. Red spiders, fleas, jumpers, and other insect attacks are also often causes of serious injury. Mould or mildew has been prevalent of late years, and sulphur is the only remedy. Sulphuring is done by a machine drawn by a horse between the rows of plants, and the dry sulphur is distributed by means of a fan-blast.

Hop-picking is an operation of public interest, and is solely performed by hand. After picking comes drying in kilns. The usual plan is to dry in circular or square kilns, furnished with cowls to carry off the reek, and many improvements have been suggested. The South-Eastern Agricultural College authorities have interested themselves particularly in hop cultivation and have made valuable suggestions. In few details have more radical changes been made than in packing. Pressing machines have taken the place of men jumping in the bags suspended in mid-air after the manner of wool-packing. Pockets have entirely superseded the old brown bags. They are made of coarse canvas, and hold $1\frac{1}{2}$ cwt. each. Hops are

found difficult to store on farms, although they can now be kept for years in properly provided warehouses. The improvements in storing, and the keen competition from America, have already been pointed out as causes of lower prices.

The cost of production.—In the older accounts of the expenses of hop cultivation the duty often amounted to £17, 10s. per acre more or less, and this raised the total cost very materially. The old growers variously estimated the expenses at £28, £38, £47, and even at £60 per acre. At the present time the cost is estimated at close upon £35 per acre. When every appliance is used to secure the best results, this estimate may be exceeded by at least £5 per acre. If we take £40 as representing the cost of a thoroughly good and liberal cultivation, it will be seen that the result must often be a heavy loss, while in other cases the profits may be large. The following detailed estimate is taken from Mr. Charles Whitehead's paper on "Fifty Years of Hop Farming," published in the *Journal of the Royal Agricultural Society*, 1890:—

	£	*s.*	*d.*
Manure winter and summer	6	15	0
Digging and dressing	1	6	0
Poling, tying, earthing, and ladder-tying	1	15	0
Nidgetting, digging, and hoeing hills	3	2	0
Stacking, stripping, making bines, etc.	0	17	6
Annual supply of poles	3	0	0
Picking, drying, packing, carriage, etc., on an average crop of 7 cwt.	10	10	0
Rent, rates, tithes, taxes, repairs, and interest on capital	6	5	0
Washing, say	1	10	0

We cannot leave the subject of hops without a word upon the beauty of their cultivation. It is always associated with rich land, fruit cultivation, and orchards. It combines the arts of the manufacturer with the toil of the rural labourer in an especial degree, and the trained bines, the kaleidoscopic effect of the poles, the symmetry of the wires, the perfect freedom from weeds, and the beauty of the foliage, all combine to raise hop cultivation above the ordinary level of agricultural operations. A dull and prosaic account of hop cultivation gives only an incomplete impression of the activity and interests involved. In order to realise the ins and outs of hop cultivation, it would be necessary to visit the hop gardens of Kent, Herefordshire, and Worcestershire, and spend a little time among the growers.

Hornbeam, The.—*Carpinus betulus*, Linn., belongs to the *Carpineæ*, a branch of the Natural Order *Amentaceæ* or catkin-bearers. It is rather a small tree, attaining under favourable conditions a maximum height of 60 or 70 feet, with a stem diameter of 2 or 3 feet. The *leaves*, which bear a strong superficial resemblance to those of the beech, are stalked, ovate, pointed, doubly-toothed, generally downy on the undersurface in the axils of the veins diverging from the midrib. The tree is monœcious, but the male and female *flowers* are borne in separate catkins; the male catkins being sessile, about 1½ inch long, with broad sessile scales. *Stamens* about twelve within each scale, without inner scales or perianth, the anthers

crowned with tufts of hair. The female catkins are slender, often several inches long, with long leaf-like bracts, the central lobe lanceolate, 1 to $1\frac{1}{2}$ inch long, the flowers two within each scale, each enclosed in a hairy, unequally three-lobed inner scale. Ovary two-celled with a pendulous ovule in each cell. *Fruit*, a small ovoid nut, with prominent ribs (Bentham). The persistent, three-lobed bracts act as wings to the seed.

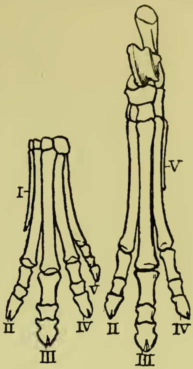
The hornbeam, which is believed to be indigenous in Eastern England, is one of the hardiest of our deciduous trees, and endures shade almost, but not quite, as well as the beech. It is seldom planted now except to form hedges, a purpose for which it is better suited than any other deciduous tree except the hawthorn; but on a chalk soil, beech is a preferable hedge plant. The timber is white and very hard, whence its name. It is seldom turned to any account in Britain, except firewood, which it yields of the best, throwing out more heat in combustion than any other wood. But on the Continent, in spite of being very difficult to work, hornbeam is much used for making carts, agricultural implements, etc. It also makes excellent charcoal.

On the whole, the only inducement to plant hornbeam, except as a hedge, is its power of resisting cold upon damp soils. It may be propagated from seed, which ripens in the southern half of Great Britain, but not in the north, and its nursery treatment is similar to that of the beech.

Horse, Evolution of.—*Eocene Horses.*—Though in North America horses had apparently died out before Palæolithic man appeared on the scene, it is to North America we must turn when we desire to study the ancestral history of the Equidæ. But while all the chief phases through which horses passed during their evolution are preserved in the Tertiary deposits of North America, the oldest known representative of the horse group is *Hyracotherium* of the London clay. The descendants of this primeval horse seem to have migrated from Europe by way of Asia into America, crossing by a land connection which long bridged the gap now known as Behring Straits. Ere the Southern States were reached these early immigrants to the New World had advanced slightly in their teeth, and probably also in their limbs, beyond their European ancestors.

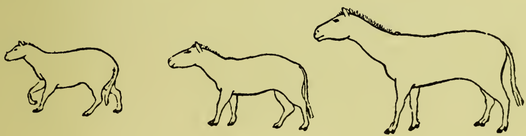
In most mammals the anterior cheek teeth (premolars) are smaller and less complex than the posterior cheek teeth (molars), but in the recent horses all the six large cheek teeth closely resemble each other in size and enamel foldings—they are all equally well adapted for crushing hard dry food. In *Hyracotherium* the four premolars differed greatly from the three molars, and even the molars were only adapted for dealing with soft green food, such as occurs along the banks of lakes and rivers. In *Eohippus* the process of converting the premolars into complex teeth like the molars had already begun—the last (fourth) premolar was already assuming molar characteristics—and before the Eocene period came to an end the second, third, and fourth premolars in the *Eohippus* group of horses resembled molars. For example, in *Protorohippus* of Wyoming and Colorado the fourth premolar was molariform, and the third was in the act of changing; in *Orohippus* of Wyoming and New Mexico the third and fourth premolars resembled molars, and the second was assuming molar characters, and in *Epihippus* from the upper Eocene of Utah the second, third, and fourth premolars as in recent horses were all molariform. As these changes in the cheek teeth of the Eocene horses were effected very slowly, they serve as an excellent example of progressive variation—of descent with

modification. *Hyracotherium* undoubtedly included among its ancestors forms with as many digits as occur in man, *i.e.* five on both fore and hind limbs; but the small Eocene horses of America had only four complete digits in front, and three behind. In the limbs as in the teeth there was evidence of progress during the Eocene period. In *Eohippus* in addition to four complete digits in front, the first metacarpal — the metacarpal which carries the thumb in man—was nearly complete though slender (Fig. 1, A), and in addition to three complete digits behind there was a splint-like metatarsal corresponding to the metatarsal of the outer toe in the human foot (Fig. 1, B). In *Protorohippus* and *Orohippus* the metacarpal of the first digit (pollex) seems to have been absent, and compared with *Eohippus* the middle digit was relatively longer. *Eohippus* (Fig. 2, *a*) measured 12 inches at the withers, *Protorohippus* and *Orohippus* (Fig. 2, *b*) about 14 inches—the height of *Hyracotherium* and *Epihippus* is not known.



A B
FIG. 1. (One-half nat. size.)

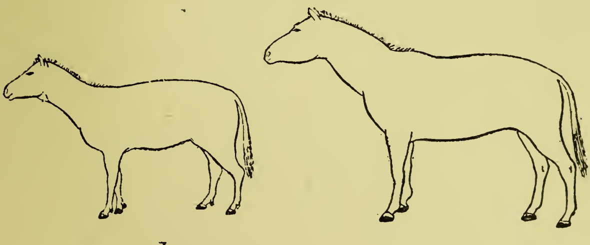
Oligocene Horses.—Beyond giving to three of the four premolars the characters of molars, nature altered but little the four-toed horses of the Eocene period. This was doubtless because the environment during the earlier part of the Tertiary period was nearly uniform, and on the whole



a. *Eohippus.* 12 inches. Eocene.

b. *Orohippus.* 15 inches. Eocene.

c. *Mesohippus.* 18 inches. Oligocene.



d *Protorohippus.* 36 inches. Miocene.

e. *Pliohippus.* 48 inches. Miocene and Pliocene.

FIG. 2. (After Lull.)

favourable. Apparently "during Eocene times North America was clad with forests in which grew both evergreen and deciduous trees distinctly

modern in character. The moist climate gave rise to many streams and lakes along the shores of which grew sedgy meadows that in turn gave rise to grassy plains."[1] Although during Oligocene times the climate by becoming dry led in some districts to the appearance of prairies, the conditions on the whole differed but little from those of the Eocene period. This being the case, no very profound modifications took place in the horses. They continued small, the majority being under 20 inches, and only a few reached a height of 24 inches. But though there was no striking increase in size, the freer life made possible by the prairies seems to have favoured variation. At least a dozen Oligocene species have been described; they differ in the teeth and limbs, in the size of the preorbital fossa, the length of the face, and in the angle the face forms with the cranium. All the Oligocene horses hitherto found have three digits in front (Fig. 3, A) as well as behind (Fig. 3, B), in some the vestige of the fifth metacarpal is over an inch in length, in others it is under half an inch.

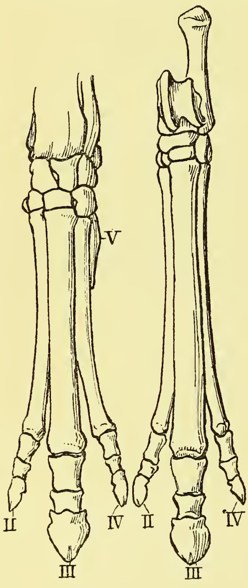


Fig. 3. (One-half nat. size.)

Evidence of progress is especially found in the incisor teeth—they gradually become cupped as in recent horses. By inverting the tip of the finger of a glove, one layer of leather comes to lie within another. By pushing in the crown of the incisor tooth one layer of enamel is made to lie within another, *i.e.* by the appearance of a pit or cup in the crown of the incisor the amount of the intensely hard enamel is nearly doubled. In the earlier Oligocene horses the outer incisors alone are cupped, but in course of time enamel pits appear in the second incisors, and later still in the inner incisors, with the result that all six front teeth, at the end of the Oligocene, were cupped,[2] and were hence as well adapted for cutting hard dry grasses, twigs, etc., as the cheek teeth were adapted for crushing them.

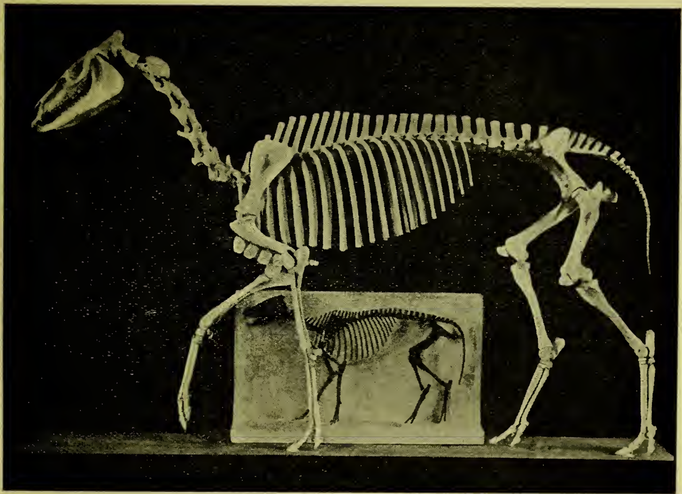
One of the best known early Oligocene horses is *Mesohippus bairdi* (Fig. 2, *c*)—a slender limbed fairly fleet form about 18 inches high; one of the later forms is *Mesohippus intermedius*, a larger and stouter built horse probably adapted for living in the vicinity of forests. Towards the close of the Oligocene, the horses reached a height of 24 inches. These larger forms are represented by *Miohippus gidleyi*—which, except in size, closely agreed with *Mesohippus intermedius*—and the European species *Anchitherium*—a species long regarded as one of the ancestors of domestic horses, but now believed to be a specialised member of the *Miohippus* type which migrated to the Old World and eventually became extinct.

Miocene Horses.—By the time the Miocene period arrived the western portions of America contained wide-stretching prairies and here and there

[1] R. S. Lull, *Amer. Journ. of Sc. Mch.*, 1907.
[2] In the living Equidæ the pit in the incisors contains "cement," and thus gives rise to the "mark."

great mountains and plateaus. As the climate became drier the lakes and forest areas dwindled or disappeared. As the forests diminished not a few of the mammals only capable of living on soft green food became extinct as the aridity increased, but others being able to adapt themselves to the changing conditions not only survived but increased in size, and, if one may judge by their limbs, some of them acquired great speed.

The earlier Miocene horses measured from 36 to 40 inches at the withers; some of the later species reached a height of 48 inches—12 hands. A careful examination of the skeletons of the Miocene "fossil" horses indicates that they were more specialised for different environments than are the Equidæ living now, some being adapted for a forest and others for



Protorohippus, a Lower Eocene Horse (4 hands high), with three toes on each hind foot and four toes in front.

Hypohippus, an Upper Miocene Horse of the Forest type (10 hands high), with three toes in front as well as behind.

Fig 4. (After Osborn.)

a desert life. One of the most interesting of the Miocene forms is *Hypohippus* (Fig. 4) of Montana and South Dakota. In *Hypohippus* the limbs were powerful, the middle digit carried a broad hoof, and the second and fourth digits were long enough to be of use in the soft ground frequented by this very typical "forest horse." As in *Hypohippus* there are minute vestiges of the first as well as the fifth digit, it must have sprung from a still undiscovered Oligocene species, for in all the known species of *Mesohippus* and *Miohippus* the fifth digit is unrepresented. That *Hypohippus*, as the limbs suggest, frequented forest areas is made evident by the teeth and by the relation of the face to the cranium. The molars have short crowns, and are otherwise adapted for dealing with comparatively soft food, while the face, as in the elk (*Alces*) and other forms adapted for a forest

life, is nearly in a line with the cranium. A specimen of *Hypohippus* found in 1901 in Eastern Colorado measured 40 inches at the withers. It is generally assumed that the Miocene "forest" horses all became extinct without leaving descendants, but it is quite possible that the heavy breeds of domestic horses have in part sprung from three-toed species allied to *Hypohippus*; this is suggested by Shires and other heavy breeds, now and again producing foals with extra digits nearly as well developed as the lateral digits of *Hypohippus* (Fig. 4).

In *Merychippus* from Texas, Montana, and Oregon we have another interesting Miocene horse represented by several species. Some of the species have a vestige of the fifth digit, in some the lateral digits are slender, in others they are fairly large. As *Merychippus* is, in its teeth, intermediate between Oligocene and living horses, it is sometimes regarded

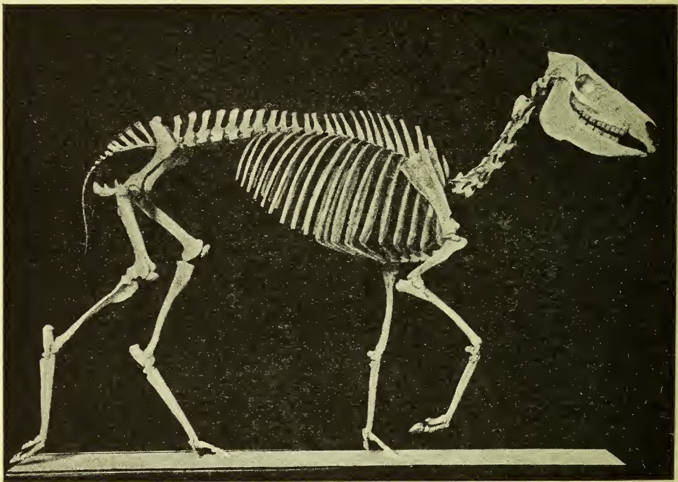


FIG. 5.—*Neohipparion*, an Upper Miocene Three-toed Horse (10 hands high), with a large head but finer limbs than in the modern Racehorse. (After Osborn.)

as the ancestor of all the recent Equidæ. In many respects more interesting than either *Hypohippus* or *Merychippus* is *Neohipparion*, a three-toed horse with limbs more highly specialised for speed than the modern race-horse. From a perfect skeleton (Fig. 5) found in South Dakota in 1902, it appears that though in *Neohipparion* there are vestiges of the first and fifth digits in front as in *Hypohippus*, the second and fourth digits both in front and behind are extremely slender, and so short that they probably never reached the ground. In its limbs *Neohipparion* may be said to more closely agree with deer than with the recent Equidæ. In a pony with a femur 310 mm. long, the third metatarsus may only measure 210 mm., but in *Neohipparion*, as in the Virginian deer, the third metatarsus is practically as long as the femur, and more slender than in the fine-limbed Onager of the Runn of Cutch.

In the molar teeth of the horse there is always a fold on the inner

aspect known as the anterior internal pillar (Fig. 6, A). In all the living Equidæ the cavity of this pillar communicates with the anterior crescent, but in *Neohipparion* the cavity of the pillar is completely cut off from the crescent, *i.e.* the pillar is quite free, as Fig. 6, B indicates. In *Hypohippus* the face is short and in a line with the cranium (Fig. 4), but in *Neohipparion* (Fig. 5) the face is long and strongly deflected on the cranium as in sheep.

As the fleet-footed *Neohipparion* lived about the time elephants reached America from Africa (by way of the dry land of the Behring Straits region) it may very well have found its way to the Old World. That this actually happened is extremely probable, because a three-toed horse with the peculiar teeth of *Neohipparion* made its appearance about the end of the Miocene period in Northern India and somewhat later in various parts of Europe. The three-toed horse of Northern India has long been known as *Hipparion.* It differs from *Neohipparion* in having less deer-like limbs, more complex teeth, and a larger preorbital depression. *Hipparion* has long attracted attention because it occurs in large numbers in the Pikermi deposits near Athens, and because it was long believed to be the ancestor of at least some of the recent Equidæ. Now, however, it is generally assumed that *Hipparion* became extinct during the Pliocene age without leaving descendants.

As in some of the species of *Merychippus* the anterior internal pillar

A B

Anterior Pillar. FIG. 6. Anterior Pillar.

seems to be in the act of detaching itself from the anterior crescent, *Merychippus* is by some regarded as the ancestor of *Neohipparion* and indirectly of *Hipparion.*

A fourth late Miocene horse deserving notice is *Protorohippus*, of the Loup Fork beds. In this three-toed horse (Fig. 2, *d*), which measured about 36 inches at the withers, there were apparently no vestiges of either the first or fifth digits, and the anterior internal pillar communicates as in the living Equidæ with the anterior crescent. Being neither specialised in limbs nor teeth, *Protorohippus* is supposed to have sprung from *Merychippus* and to be the progenitor of the next form to be mentioned, namely, *Pliohippus*, which some authorities regard as the first of the one-toed horses and the ancestor of all the subsequent Equidæ. *Pliohippus* (Fig. 2, *e*), though originally supposed to be confined to Pliocene deposits, really occurs in the upper Miocene beds. Several species measuring about 12 hands have been found in Nebraska and Oregon. As the lower ends of the second and fourth metacarpals and metatarsals are missing in the skeletons hitherto examined, it is impossible to say whether *Pliohippus* was a one-toed or a three-toed horse, with the second and fourth digits as small as in *Neohipparion.* It is also impossible to say what relation, if any, *Pliohippus* has to *Protorohippus* on the one hand, and the first true horse hitherto discovered (namely, *Equus sivalensis* of Northern India) on the other. As *Pliohippus* has simpler

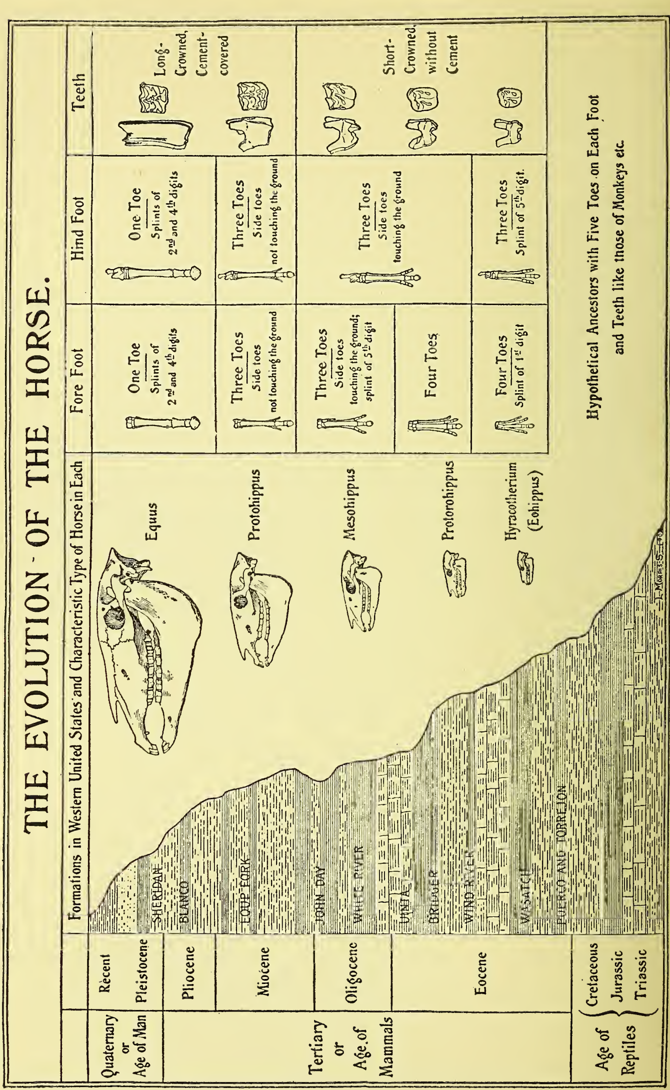


Fig. 7.—Epitome of the History of the Horse. (After Osborn.)

teeth than *Protorohippus* and differs in the skull and limbs as well as in the teeth from *E. sivalensis* and other true horses of the Pliocene period, it may neither be related to any of the known Miocene species nor stand in the relation of an ancestor to either pre-glacial or post-glacial species.

Until recently it was supposed that domestic horses had sprung from the *E. fossilis* of the Pleistocene period, and that *E. fossilis* was connected by a single line of ancestors with *Eohippus* of the early Tertiaries. Now, however, that it is realised that from Eocene times onwards several species of horses have lived, at the same time, in the same area—just as several species of zebras to-day occupy the same area in Africa—naturalists no longer attempt to say which of several possible Eocene horses survived to form the Miocene horses, or which of the Miocene species ultimately gave rise to the Pliocene species from which in due time were derived the recent horses, asses, and zebras.

Origin of Domestic Breeds.

It is now realised that in addition to an intimate knowledge of the peculiarities, mental as well as physical, of the strains the breeder is specially interested in, as complete a knowledge as possible should be acquired of the origin and history of the races and breeds to which the strains belong. In the case of the horses living under domestication a final decision has not yet been arrived at as to their origin, and there is surprisingly little known of the history of some of the breeds. Some believe all the domestic races and breeds have sprung from a single wild species, others hold they are a blend of several species, some of which were domesticated in Asia, while others were first tamed in Europe or North Africa.

If domestic breeds have had a single origin—have all descended as some now assert from a species akin to the wild horse (*Equus prejevalskii*) which still survives in Central Asia—very little need be said about their origin. It will only be necessary to indicate how light as well as heavy breeds have been derived from a species characterised by a large coarse head and slender limbs, an upright mane, and a mule-like tail, and by an indomitable temper, which hitherto has made their domestication by the Mongols an impossibility.

If, on the other hand, domestic breeds have sprung from several wild species, domesticated at different times and in different areas, it will be necessary to ascertain if possible how these wild species essentially differed, the areas they frequented, and how when tamed they were blended to form the more important races now in the service of man.

If in Palæolithic times, before man began to domesticate animals, all the wild horses of Europe and Asia belonged to a single species, it may be safely assumed that the modern breeds and strains have all descended from the same wild stock—have probably, as Darwin believed, sprung from a yellow-dun species more or less striped. But if the horses hunted by Palæolithic man belonged to several perfectly distinct types, the probability is that our modern breeds are a blend of several distinct species.

The oldest member of the genus *Equus*, *i.e.* the oldest true horse we are acquainted with, is *Equus sivalensis* of the Siwalik Hills of Northern India. This horse suddenly made its appearance in India during the Pliocene age. Hence it may be assumed that it had its birthplace north of the Himalayas —if it did not actually come ready made from North America.

At a somewhat later period *E. sivalensis* was joined by a second species, *E. namadicus*, which instead of herding with the original immigrants to the east of the Jhelum River—one of the five rivers of the Punjab—moved southwards and eventually settled for a time in the Narbada valley.

E. sivalensis seems to have been a large, "Roman-nosed," long-limbed horse—it probably measured about 15 hands—not unlike some of the modern English thoroughbreds. From the material in the British and Indian Museums the horse which in Pliocene times frequented the foothills of the Himalayas seems to have been characterised (1) by a long face strongly bent downwards on the cranium, as in sheep and other forms adapted for grazing on short herbage, (2) by the presence of a large first premolar (wolf tooth), (3) by the shortness of the internal pillar of the premolars, and (4) by the fineness of the cannon bones—the length of the metacarpals being seven times the width of the shaft. From the size of the head and the length of the limbs, it may be assumed the Siwalik horse had a long neck and high withers—it probably had in addition long quarters and a high set-on tail, and thus decidedly differed in make from the wild horse of Mongolia.

In *E. namadicus* the internal pillars of the upper premolars are very long and the milk molars have square crowns. Though differing in these respects from *E. sivalensis* as in the Siwalik horse, the first premolar ("wolf" tooth) was usually large and persistent. The Narbada valley horse was probably smaller but more heavily built than *E. sivalensis.*

At the beginning of the Pleistocene period a third horse probably reached Northern India. This is suggested by teeth found in Burmah, some of which belonged to a small species which perhaps at a later period played an important part in the making of Burmese, Borneo, Java, and other ponies of South-eastern Asia.

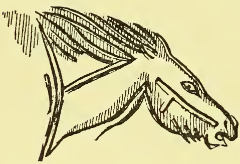


Fig. 8.—*E. gracilis* type.

Shortly after *E. sivalensis* appeared amongst the sub-Himalayas, horses belonging to several distinct types reached Italy and other parts of the south of Europe, and from thence they migrated to North Africa in the south and as far as England in the north. From the remains of these Western immigrants found in deposits in Umbria, Algiers, England, and elsewhere, it appears that one species (generally known as *E. stenonis*) resembled *E. sivalensis* except in the limbs, which were of a coarser build, that a second species had a general resemblance to *E. namadicus,* while a third species in some of its characters suggested the striped horses of South Africa.

From the sculptures and engravings made by the Solutrian and Magdalenian races of Palæoliths we learn something of the make of the horses which inhabited the south of France during the later portion of the Stone age. Some of the engravings (Fig. 9) represent horses which in all their points closely agree with the wild species (*E. prejevalskii*) recently discovered in the Great Gobi Desert; others represent a stout horse (Fig. 10) with an elk-like nose, short legs, and rounded quarters—a horse closely resembling the broad-browed, richly striped ponies occasionally met with in the Western Highlands of Scotland, while others strongly suggested the slender-limbed ponies with a narrow head and a fine muzzle (Fig. 8) still occasionally met with in western and north-western Europe.

The portions of skeletons discovered in Pleistocene deposits indicate that during the Ice age South and Central Europe and perhaps also North Africa possessed horses of the following kinds:—

(1) Broad-browed horses about 13.2 hands high, with a short face in a line with the cranium, broad cheek teeth, a long body, rounded hind quarters, the tail set on low, and the limbs so short and thick that the

metacarpals are in length only five and a half times the breadth. For these thick-set horses the name *E. robustus* may be reserved.

(2) Horses about 12·2 hands high, which in their teeth and probably in all their other points were almost identical with the wild horse of Mongolia (*E. prejevalskii*), a horse characterised by a long, coarse head and somewhat slender limbs.

(3) Narrow-browed, long-faced horses about 14 hands high, probably built on the same lines as *E. prejevalskii*, but with coarser limbs. For

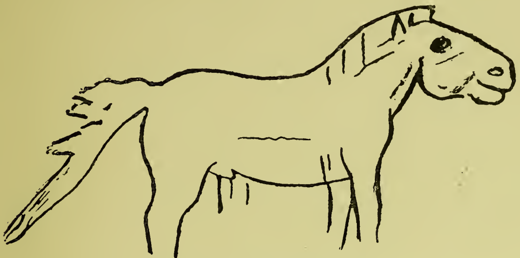


FIG. 9.—*E. prejevalskii* type.

this horse (a nearly complete skeleton of which was found at Remagen in the Rhine valley) the name *E. stenonis* may be retained.

(4) Small slender-limbed horses with small teeth and a small, narrow skull, fine muzzle, a long neck, and the other points which we associate with ponies and the finer kinds of Arabs. For these small, fine horses (in which the length of the metacarpal is seven and a half times the width) the species *E. gracilis* may be formed.

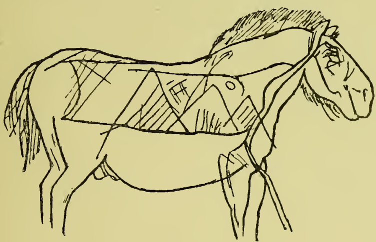


FIG. 10.—*E. robustus* type.

In addition to these four Western types there were during the Ice age others in Asia, some probably resembling the large "Roman-nosed" *E. sivalensis*, some the smaller but more heavily built *E. namadicus*, and some perhaps not unlike the narrow-browed, slender-limbed, long-faced ponies still common in South-eastern Asia.[1]

As *E. robustus*, like the Miocene species *Hypohippus*, was evidently adapted for browsing on leaves and twigs as well as on the soft grasses found in low-lying forest areas, it may be spoken of as the Forest variety.

[1] The small Oriental horse, which probably differed from the small Occidental horse in having the face bent on the cranium, may be provisionally known as *E. mandalensis*.

In all probability *E. sivalensis,* like *E. prejevalskii,* was adapted for a life on dry, barren, rugged areas such as are still common in Central Asia. These two species may hence be said to belong to a Steppe variety. The northern and southern races of *E. gracilis* being apparently adapted for a life on boundless plains, may be said to belong to a Plateau or Desert variety.

The question now arises, Which of these varieties took part in forming the more important domestic breeds?

At the beginning of the nineteenth century naturalists with few exceptions, following Cuvier, believed that all the horses from the Pleistocene deposits belonged to the same species, and that living horses only differed from each other in size. But in 1841 Colonel Hamilton Smith published a work in which he advocated the view that domestic breeds had been derived from five distinct wild *stirpes,* namely, the bay, the white, the black, the dun, and the piebald. Mr. Darwin, being unable to agree with Hamilton Smith, adopted the view of those naturalists who "from the fertility of the most distinct breeds when crossed, look at all the breeds as having descended from a single species." For a time Sanson held that domestic breeds were derived from eight species.[1] Now, however, Sanson believes domestic breeds are a blend in unequal degrees of two varieties—*E. c. asiaticus* and *E. c. africanus.* Pietrement, another distinguished French hippologist, though believing horses were tamed in eight separate areas, holds they have all descended from a single species. Frank and other German naturalists recognise two distinct varieties, an Oriental, represented by the Arab, and an Occidental, represented by the heavy horse of Germany—Sanson's *E. c. germanicus.*

According to Professor Ridgeway, all the improved breeds of the world have resulted from the blending in varying degrees of a fine bay African species (*E. c. libycus*) with a coarse, thick-set species which originally inhabited Upper Europe and Upper Asia. The fine bay horse of North Africa, Professor Ridgeway thinks may have descended from a variety of *E. stenonis.* The coarse, slow horse of Upper Europe and Upper Asia he regards as a near relative of, if not identical with, *E. prejevalskii.*

The only other view as to the origin of domestic breeds that need be referred to is the one recently promulgated by Mr. Lydekker in the *Guide to the Equidæ in the British Museum.* Mr. Lydekker recognises (1) a northern or dun type, which, he says, "may be regarded as probably derived from the Wild Mongolian Horse, and likewise as the main ancestral stock of the ordinary domesticated horses of north-western Europe," and (2) a southern or Barb type represented by Barbs, Arabs, and Thoroughbreds. Mr. Lydekker says that *E. sivalensis* "may have been the ancestral stock from which Barbs, Arabs, and Thoroughbreds are derived." It thus appears that while Professor Ridgeway regards the improved breeds as a blend of a northern or Prejevalsky type and an African type, Mr. Lydekker regards them as a blend of a northern or Prejevalsky type and an Indian type.

Arabs.—The Arab breed includes several strains which materially differ in their points. From the examination of the available material I have arrived at the conclusion that a high-caste Arab should have the following amongst other characters: the face narrow, ending in a fine muzzle and only slightly deflected on the cranium, the frontal index from 54 to 56,[2] the cervical vertebræ decidedly longer than in *E. prejevalskii,*

[1] These species were—(1) *E. caballus africanus,* (2) *E. c. asiaticus,* (3) *E. c. germanicus,* (4) *E. c. frisius,* (5) *E. c. belgicus,* (6) *E. c. britanicus,* (7) *E. c. hibernicus,* and (8) *E. c. sequanius.*

[2] This index is obtained by dividing the width of the face by its length as measured from a line connecting the foramina above the orbits and the space between the central incisor teeth.

the lumbar (loin) vertebræ five in number, and the metacarpals in length seven and a half times their width.

Arabs presenting the above characters are probably nearly pure descendants of the Pleistocene species *E. gracilis.*

During the Ice age this species seems to have varied in two directions, to give rise to a northern race—adapted in some cases for a subarctic habitat—and a southern race adapted for a subtropical habitat. The Celtic pony of north-western Europe, *i.e.* the lightly-built, rough-coated, small horse, with only two of the eight callosities, is probably a nearly pure descendant of the northern variety; the small horses in possession of the ancient Libyans—Professor Ridgeway's *E. c. libycus*—were probably equally pure representatives of the southern variety.

Of some twenty skeletons recently found in the Roman Fort near Melrose, one in the skull and limbs completely realises one's conception of a 14-hands high-caste Arab, one evidently belonged to a 12-hands pony of the pure Celtic type,—the larger one may have been a nearly pure specimen of the North African variety of *E. gracilis*; the other was probably a British pony presenting all the chief points of the northern variety of *E. gracilis.* Very few of even the smaller varieties of living Arabs reach the standard attained by the two horses from the Roman Fort at Newstead.

In addition to Arabs with a fine narrow head, a frontal index of 54, and the deflection of the face on the cranium from 4 to 6 degrees, there are broad-browed Arabs with the face in a line with the cranium and the metacarpals in length seven times the width of the shaft. Many of the Arabs with a broad brow and a short face are white, or nearly white, in colour, and extremely good-looking. In having a frontal index of nearly 60, the face in a line with the cranium, and the anterior internal column of the molars elongated, these good-looking and docile but not, as a rule, very fleet Arabs, are far removed from both *E. prejevalskii* and *E. sivalensis.* They are in all probability a blend of *E. gracilis* and *E. robustus, i.e.* of the plateau and forest types.

The only other variety of Arab that need be referred to is well represented by Sanson's Dongola race—a race characterised by a long ram-like head in which the face is strongly deflected on the cranium, by long slender limbs, high withers, a short back, long hind quarters, a high set-on tail, and narrow hoofs. Members of this variety, though sometimes neither handsome nor tractable, are usually very fleet, and possess great staying power. As the ram-headed Arabs have little affinity to either *E. gracilis* or *E. robustus,* they are in all probability the offspring of horses of the Prejevalsky or Sivalensis type, modified by crossing with Arabs of the *E. gracilis* or plateau type. This view is supported by hybrids obtained by crossing Celtic ponies with *E. prejevalskii.*

Barbs and Turks are frequently distinctly ram-headed, though often like high-caste Arabs in other respects—in, *e.g.*, the long, slender limbs, well-laid shoulders, long neck, short back, long hind quarters, and high set-on tail. Hence it may be inferred that Barbs and more especially Turks and other Asiatic breeds, including the Kathiawar ponies of India and long-headed Kirghiz horses, have in great part sprung from ancestors closely allied to *E. sivalensis.*

The *English Thoroughbred* has inherited its chief traits from Arabs, Barbs, and Turks. When a large number of thoroughbreds are inspected, there is no difficulty in noting in some of them affinities to high-caste Arabs, more especially in the smaller thoroughbreds with a fine narrow

FIG. 11.—Shire.

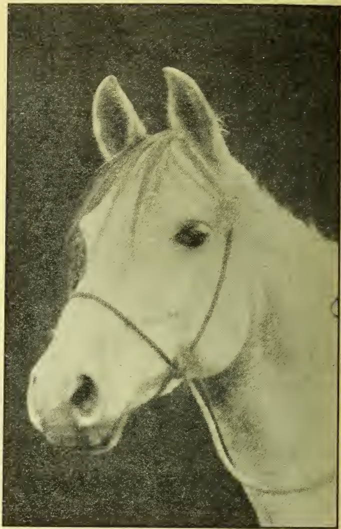


FIG. 12.—Arab.

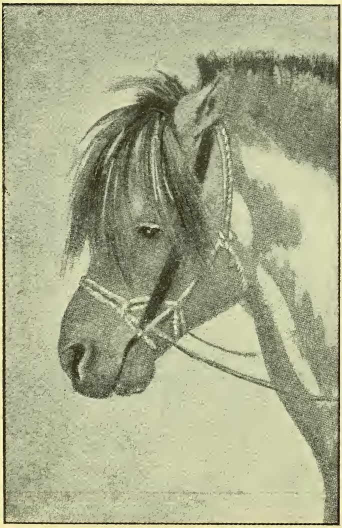


FIG. 13.—Norwegian.

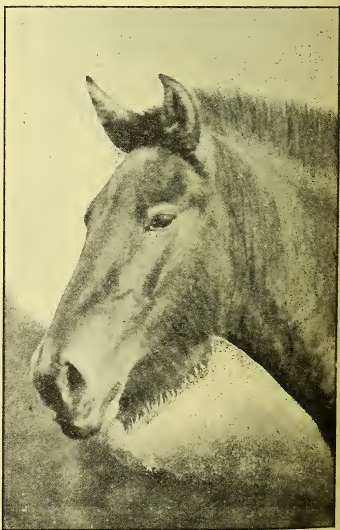


FIG. 14.—Prejevalsky.

head; nevertheless, it must be confessed that the majority of English race-horses are far more like Turks than desert Arabs. The only explanation of this is that ancestors of the *E. sivalensis* type have been more concerned in the making of the English race-horse than pure desert Arabs. This view is supported by a study of skeletons of thoroughbred horses. The skull of Stockwell, *e.g.*, far more closely agrees with the skull of *E. sivalensis* than with the skulls of the plateau type found at Newstead Roman Fort, or with the skull of the Arab Jerboa in the British Museum. In Stockwell, the deflection of the face on the cranium probably amounts to 16 degrees—several degrees more than in some specimens of *E. prejevalskii*, and 10 or 12 degrees more than in Arabs of the forest type.

The *English Shire* horse is characterised by coarse powerful limbs and a large head, the long face being strongly deflected on the cranium as in sheep and goats. It hence differs from all the known Pleistocene Occidental varieties. According to writers on the history of the Shire breed, it originated from the crossing of English mares with stallions imported from the Low Countries and the banks of the Elbe during the thirteenth century. One of the horses in the Roman Fort at Newstead had the skull relatively as large and as bent as in, *e.g.*, the Shire Blaisdon Conqueror.

There was probably in England during the thirteenth century an excellent foundation for the famous English Great Black horse, from which the modern Shire was mainly derived. Professor Ridgeway says, "Our best English breeds of cart horses owe their excellence to the North African horses." This conclusion seems to have been arrived at because it was assumed "that the black breeds of the world are the result of mixing the African blood with that of the horses of Europe and Asia." As already mentioned, a fine-limbed pony of the *E. gracilis* or plateau type crossed with one of the wild horses of Upper Asia (*i.e.* with Prejevalsky's horse) instead of yielding a hybrid with coarse limbs and large hoofs, produced a hybrid which very closely resembles a long-faced Arab. This and many other experiments make it clear on the one hand that Shires have not been formed by blending a variety with a small head and slender limbs with a variety characterised by a coarse head and somewhat fine limbs, and on the other hand that heavy breeds have almost certainly sprung from a coarse-limbed race of the *E. robustus* or forest type and a coarse-headed race allied to *E. sivalensis*.

The *Clydesdale* now differs but little from the Shire, but a generation ago the head in this northern breed was smaller and less "Roman-nosed," and the limbs were finer and the pasterns longer.

From the fact that in Clydesdales the hind chestnuts and ergots are sometimes very small and the tail has sometimes a tail-lock, it may be assumed that they have in part sprung from the Celtic race, which is still found in a more or less pure form in the Highlands and Islands of Scotland. Further, while in Shires the *E. sivalensis* type has long been dominant, in Clydesdales the broad-browed or forest type originally prevailed—*i.e.* the type which still persists nearly unaltered in the richly striped yellow-dun horses of the north-west of Scotland.

The *Percheron* breed includes small varieties, forest-like in build, larger varieties presenting many of the points of Sanson's Dongola race and a heavy variety which closely resembles the English Shire. The Percheron breed is hence one of great intermixture. Percherons, usually black at birth, as a rule become grey, and when old are often white. Originally this famous French breed differed but little from the Great Black horse of England. But some generations ago the Percherons were crossed by

white Arab stallions, which in make seem to have resembled the large race of Arabs long maintained by the King of Wurtemburg. Before this infusion of Eastern blood, some Percherons appear to have been related to the "Roman-nosed" heavy horse of Germany, while others were allied to the broad-browed horse of Ardenne. It may hence be assumed that the modern Percherons are a blend of the steppe, forest, and plateau types,—some having the long deflected face of *E. sivalensis*, others the broad, short face of Highland ponies, and others approaching in the form of the head the Celtic ponies.

The Norwegian fjord horse.—Mr. Lydekker, in the *Guide to the Equidæ*, says, "Whether the Celtic pony is a separate race or merely a modified and domesticated Tarpan, there can be no question that the dun type as typified by the Norwegian Dun Pony is a distinct race." He then states that the Norwegian ponies "are evidently related to the Wild Mongolian Horse, but have a fuller development of the mane and tail." I have examined the skulls of a number of Norwegian ponies. In every case the skull was extremely unlike that of Prejevalsky's horse. The face in Prejevalsky's horse is very long, whereas in a typical Norwegian pony the face is very short—so short and broad that the frontal index may be over 60, while in Prejevalsky's horse it may be under 50. In usually having six lumbar vertebræ, the hind chestnuts and ergots small or absent, relatively small teeth, and an elk-like muzzle, Norwegian ponies differ from Prejevalsky's horse. Moreover, ponies having all the essential points of the northern or dun type are at once produced when broad-browed Highland mares are crossed with a Celtic pony stallion. This implies that the Norwegian dun or fjord horse is mainly a blend of the forest and plateau varieties—that it is as far removed as any race can well be from the steppe or Prejevalsky type.

In the *Shetland pony*, as in the fjord horse of Norway, Prejevalsky traits are, as a rule, entirely absent. Originally the Shetland pony probably closely resembled the Norwegian pony, but from artificial selection this dwarf race now presents nearly all the characteristics of the broad-browed forest variety; they are, as a rule, a blend of *E. robustus* and *E. gracilis*—the former predominating.

The *Connemara* ponies in many ways agree with Barbs and other so-called Eastern varieties and with ponies frequently met with in the valley of Mexico. But while in the majority the face is long and bent on the cranium as in *E. sivalensis*, in some it is short, broad, and nearly in a line with the cranium. The smaller kinds of Welsh ponies closely resemble the Celtic ponies of the Outer Hebrides, in which there is a dash of forest blood, while the Exmoor ponies have often the head as fine and narrow as the purest specimens of small desert Arabs.

In many ways the ponies of South-eastern Asia are extremely interesting. It has been generally assumed that they are mainly of Arab origin. They may in some cases be saturated with Arab blood, but from the skulls I have examined it is evident the foundation stock is Eastern in origin. The face is usually long, narrow and deflected, and in some cases the occipital condyles are only separated by a very narrow groove. Further, the molars are small and the preorbital depression is sometimes deep, as in *E. sivalensis*. In all probability the ponies of Java, Sumatra, and other islands of South-eastern Asia have in part sprung from a species which migrated from Central Asia in a south-easterly direction about the same time that *E. stenonis* was moving westwards to reach Europe, *i.e.* from the variety which I have provisionally named *E. mandalensis*.

Horse Breaking.—One of the most mischievous mistakes, made almost universally by the ordinary class of breakers, is to subject all horses to a precisely similar course of treatment, whereas the very essence of successful breaking is to understand each animal's particular temperament and idiosyncrasies, and to adapt and vary the training in accordance with the requirements of each particular case.

The first essential in the would-be horse-trainer is that he must either possess naturally, or acquire, the art of controlling himself and his temper. Without this it is impossible for him to attain the ability to control the horse. A quick-tempered or irritable man will inevitably develop a bad-tempered or nervous colt, and a man with a really vicious and uncontrollable temper will not take long to create a really vicious and dangerous horse. It is not always the system which is responsible for failure in training—by any means. No two colts or horses possess precisely the same natural inclinations, character, and temperament; and each, therefore, must be dealt with, to a more or less extent, in a different way, in order to secure the best results.

With regard to lunging—the at-one-time universally accepted remedy for all the vices that the horse is heir to—I am quite convinced that, although a very little of it may not be positively harmful, it is quite useless in itself, and best left alone altogether. It is at best only a lazy way of exercising a colt, is often done with little care or judgment, and tends to make one side of the animal's mouth harder than the other—a defect which is always difficult to remedy. Hundreds of colts have been ruined by being "lunged" by lazy, thoughtless, or unskilled hands. Bad habits of various kinds have been generated and confirmed by it, and evidence of its abuse is frequently to be found in the shape of lameness, curbs, and spavins.

To sum up, I think the system of lunging is full of risks, drawbacks, and disadvantages, and, in my opinion, the long-rein treatment is incomparably better in every way.

As is generally recognised, the younger the colt when its breaking commences, the easier is the subsequent work of the trainer. At an early stage of its existence it will, in the ordinary course of things, be brought up to be gelded; and it is at this period that a few days' "handling," such as haltering and leading, gentle grooming or rubbing all over with a bulky soft cloth, picking up the feet, etc., will be very useful. The future work of the trainer will be materially lessened thereby, and risk, time, and expense will be saved. In the Colonies, however, the stockmen appear to have no time for these preliminary processes.

Wherever possible, however, the early training should always be given.

Catching a Colt and Teaching it to Lead.—There is no great art or skill required to catch and halter a colt by the following method, but the process generally enforces a little patience and pluck. Perhaps the handiest kind of halter to use is the ordinary rope and web one, having an extra long shank. Prepare the halter as follows: withdraw the shank from the eyelet hole in the web portion of the head collar, tie an ordinary knot close to the head part, leaving sufficient room between the knot and the head collar to form a jaw piece, repush the shank through the eye again and pull it, the use of the knot will then be shown, *i.e.* to prevent the rope from jamming and cutting into the lower jaw. Partially redraw the shank, until you have a large loop, hang the halter on to a long stick by the poll part, the large loop hanging down. Be mindful to hold the end of the shank in your left hand, directly you have inveigled the colt's head

through the large loop, quietly and quickly drop your stick and pull the halter shank.

As soon as the halter is on, pull the horse's head smartly and strongly

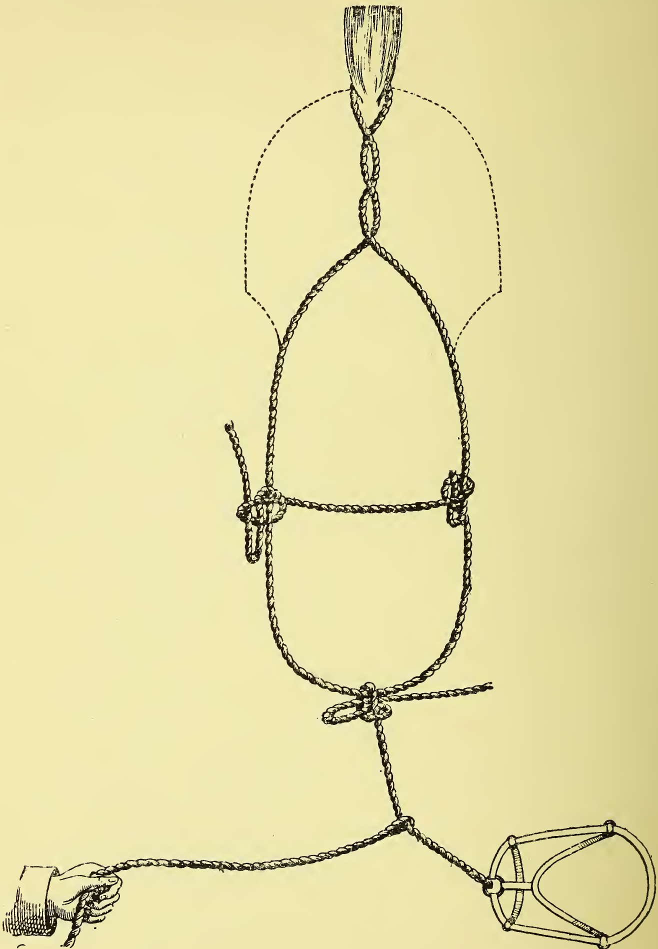


Fig. 1.—The Hair, or Leading Rope, when adjusted.

Note.—The swinging rope is held in the hand.

to the near side, place your right hand on its quarters, and simultaneously give a strong push. Repeat this several times, then seize the animal's tail with your right hand, taking a short hold of the halter shank with your

left, and give the colt a few smart turns round. The correct way to hold a colt by the halter, when standing on the near side, is to grasp the shank close to the jaw with the left hand, and to hold the end of the shank with the right. There should be a knot at the extremity of the shank, to prevent it from being drawn through the hand. If the colt struggles at all, the breaker must pull with his left hand and push the animal's quarters with the right, thus turning the colt round and round.

You should provide yourself with a rope, about 14 feet long, with a loop one end—a mixture of horsehair and hemp is the best—but any rope will answer about as thick as a stout finger.

The next thing is to take the looped end of the hair rope (which should have been placed handy somewhere) in your left hand, double it so as to make a sort of crupper (see Fig. 1), the looped end being the short one. Holding the loop, and the portion of rope level with it, with your left hand, and

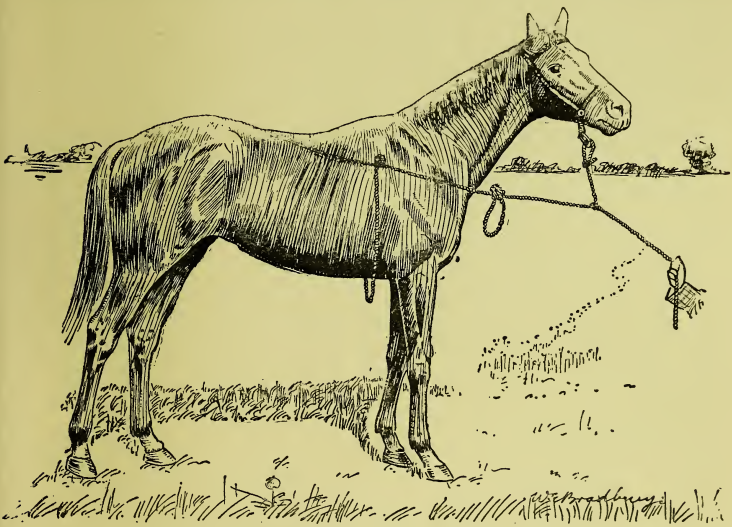


FIG. 2.—A Colt being taught to lead by the Author's Method.

having the rest of the rope thrown over your left shoulder, put your left hand gently upon the colt's back and divide the rope, allowing the so-made loop to fall down its quarters, forming a sort of breeching. Then lift its tail quietly with your right hand, at the same time pulling the rope with your left hand towards its withers, thereby bringing the loop into exactly the same position as a crupper, and *gently* lower the tail. Twist the short end a time or two round the rope, pass the long end to the off side and bring it round the chest to the near side. Pass the end through the loop, fasten off with a single hitch on the loop, throw the end of the rope quietly under the belly, go round to the off side and finish off with two single hitches, leaving the belly-band loose (see Fig. 2). Take the "swinging rope" (a strong piece of rope about 6 feet long, with a loop at one end), pass the shank through it, and then tie the shank in a half bow to the hair rope

in front of the chest. When this is done lead the colt round and round a time or two, then walk in front of it, and give it several smart, strong jerks, still continuing to walk on. The hair rope will nip its tail, and make it come forward immediately. This method is infinitely better in every way than the old one of endeavouring to drag it forward by the head alone, which chokes it more or less, and causes it instinctively to struggle and hang back. My method, on the contrary, simply nips the tail end of the animal slightly, and thus creates a natural and instinctive tendency to come forward.

Under the old system of haltering for leading there is always the likelihood of the animal, when lying down or rising in the stable, putting a heavy strain upon the halter and thereby causing a choking sensation from which it will naturally struggle violently to release itself (a sequence to its early training). Under such circumstances the system herein advocated simply allows the rope to nip the tail, making the horse come forward instead of hanging back, and it is in the hanging back and fighting that the danger lies. *After* the colt has really hung back once or twice, it is then *necessary* to fix a piece of *washleather* or *soft rag*, round the portion under the tail to *form a crupper*, otherwise the colt's dock will become excoriated.

A similar method is also to be recommended in the treatment of horses which have acquired the confirmed habit of hanging back in the stables and breaking their halters.

Note.—If the colt is caught in the ring, break him as described hereafter in this article, and leave the process of swinging and leading till last, *i.e.* until it is tied up in the stable, being careful to make a soft crupper straight away. In all probability the "Galvayning" process will render the use of the hair rope unnecessary.

The Basis and Principles of the "Galvayne" System for Breaking and Taming.—There are few, if any, writers on "Breaking" generally who have even attempted to explain the basis upon which they have formulated their systems or methods. Of course those writers on the subject who were, or are, practical experts themselves must be supposed to have had a basis of some sort or other, but they cannot be said to have succeeded in expounding it to the ordinary reader, in those few cases where any attempt has been made to do so. In fact, the existing works on the subject are usually of so abstruse a nature that it is difficult even for the expert, familiar with all the details and technicalities of the profession, to follow them intelligibly.

In expounding my system of handling, training, and managing the horse I have made a special feature of endeavouring to give a solid, practical, and scientific reason for every step I advocate, and the advice I give is based upon actual, practical, and personal experience, and the most careful observation. The system with which my name is identified is the result of a lifetime's experience of horses of all classes, kinds, and nationalities, and of the closest observation of their habits, diverse temperaments, and idiosyncrasies. In the course of many years of public teaching and exhibitions in Great Britain I afforded ample opportunities of testing the soundness and efficacy of my theories, by the handling of thousands of colts and horses, without having a single failure recorded against me, and I think it would be superfluous to say more to justify my claim to speak with authority on the subject. I will commence the practical exposition of my system by explaining the natural laws and instincts of the animal.

The horse is, by nature, gregarious in its wild or semi-wild condition.

Under such conditions it is always found in "mobs"; and in consequence of this gregarious tendency it is always easier to drive a mob of wild horses than a single wild one. In fact, even in the trained or civilised horse the gregarious instinct is not entirely eliminated. Anyone can easily satisfy himself of the truth of this by turning such a one loose in a field; if there are any others there it will invariably neigh and make towards them at once. In consequence of this tendency I always advise that a colt should be broken by itself. It should be ridden out alone, and its training effected out of view of other horses; otherwise its persistent efforts to join their company will entail upon the trainer a serious amount of avoidable trouble. If the colt be ridden a number of times alongside another it will refuse to leave the stable or premises without a mate, and if absolutely forced to do so will develop a tendency to insubordination, rearing, restiveness, etc.

Another natural law or instinct of the colt or horse is to *follow* any moving object with which it is unacquainted, or unfamiliar with, if that particular object be moving *away* from it. But directly the object stops, the animal will stop also. If the object turns and approaches it, the horse becomes alarmed, whereas its predominant feeling hitherto has been, apparently, curiosity. If being ridden at the time, its rider may have difficulty in retaining his seat, and in keeping its head towards the object. Should the latter continue to approach, the animal's fear will increase to such an extent that it will become violent, and eventually turn and bolt. An experience of this kind may implant in it such a terror of the object in question that much careful handling will be required before the feeling becomes thoroughly and permanently eradicated.

It will be apparent to the reader how flagrantly injudicious and irrational it is to flog or spur a horse for being afraid of any particular object, as the animal naturally associates and identifies the object with the abuse and maltreatment it receives. Many horses that may have shied at any small, unusual object in the road, through nervousness, have developed into confirmed "shyers" through being whipped or spurred for shying in the first place, and the demoralising effect of such treatment is evidenced by the fact that, after shying, they jump or cringe—in expectation of punishment.

Kicking is one of the horse's natural, primitive laws and inherent instincts, the eradication of which should be one of the most essential features of the animal's early training; although, strange to say, this obvious fact is practically ignored under the old system of breaking and training, and no specific instructions for the treatment and cure of the habit are given in the existing works on the subject—so far as I am aware. A horse that kicks, say at a leading bar touching it on the hocks for the first time, and succeeds in clearing itself, can never be considered really safe afterwards, unless subjected to a thorough course of scientific treatment on the lines hereinafter laid down.

With regard to the senses of the horse, it may appear superfluous to the general reader for me to state that they are five in number, the same as our own, namely, feeling, hearing, seeing, smelling, and tasting. But astonishing as it may seem, it is nevertheless a fact that there are, or were, very many professional horse-breakers and experts entirely ignorant of this elementary fact.

Surely no system of "training" any animal can possibly be successful and complete if it be not based upon an accurate and intelligent know-

ledge of the natural laws of the animal, and of its senses, instinct, and idiosyncrasies.

Of all the senses of the horse that of feeling is the most important, from the "breaker's" point of view, owing to the number and variety of the forms in which it has to be educated. For example, the animal must be habituated, through the training of this sense, to the halter, bit, collar, saddle, the harness generally, the whip, the spur, etc. etc.,—each item of which demands a separate and special training in itself. The sense of sight is next in importance, from the same point of view. The animal's range of vision is not so extended as our own, although a contrary impression might be created by the fact that it frequently notices the approach of an object before its rider does so. The real explanation of this, however, is that the rider is thinking of extraneous matters and is not incessantly on the watch, whilst the horse instinctively and constantly observes its surroundings.

The sense of hearing is fairly strong in the horse, and the animal frequently hears sounds that escape its rider, usually, however, for a similar reason to the one indicated above, namely, that its attention is not otherwise engaged, and that it is constantly open to receive outside impressions through the medium of its primitive senses.

The sense of tasting is, of course, a purely local one. The animal, with its tongue, ejects from its mouth anything which is offensive to its sense of taste, and demonstrates its disapproval and disgust by extending its head and curling its lips. It is by operating upon this sense that the circus-horse trainer is able to make his horse appear to laugh.

The sense of smelling is not, in my opinion, strongly developed in the horse, although many think otherwise, basing their opinion upon the frequency with which the animal snorts. But there is really no connection between the act of snorting and the exercise of the sense of smelling. Snorting is the animal's method of expressing a variety of emotions, such as curiosity, nervousness, terror, anger, and defiance, and also vice. The kind of snort, and the vehemence with which it is emitted, indicate readily, to those in the habit of handling unbroken stock, the real nature of the emotion the animal wishes to express.

To secure the complete training of the horse it is absolutely imperative that those of its senses which are capable of tuition be thoroughly and intelligently educated. The first to be dealt with, although, as previously stated, not the most important, is that of sight. The horse must be taught to recognise its trainer, and allow the latter to approach it without exhibiting fear or resentment. It is quite customary for horsemen to approach a horse in the stable solely on the near or left side. This is a mistake. To ensure the perfect training of the sight of the animal it must be accustomed to being approached with safety from either side, the advantages of which will be obvious. I may here mention, for the information of the novice, that in stable parlance the near or left side is called the right side (on which to approach the horse), and the off or right side of the horse, the wrong side. The reader has probably heard on more than one occasion some such remark as the following, "Don't go up on the off side of that horse or you will get kicked." But there is no reason whatever, except the lack of proper training, why a horse should have a quiet and safe side, and an unsafe and dangerous one. It should be, and can be made, equally approachable from either side.

The sense of feeling is the one that requires the most patient and assiduous training. In the first place, the animal must be accustomed to

the feel of the halter, a pressure on which must indicate to the colt that progressive or forward movement is required. The instinctive impulse of the animal, when it feels the halter clutching it round the head and throat for the first time, is to free itself from its embrace. The more it pulls, in order to accomplish this, the greater is the punishment it receives, and the usual result, under the old system of training, is that the colt continues to pull until utterly exhausted, and "choked down," or "something" else happens.

My system of teaching colts to lead has been explained and obviates all struggling and fighting.

"Galvayning" is really a scientific utilisation of the animal's strength against itself. It embodies and illustrates the principle upon which the whole of my humane and practical system of treatment is based, and is diametrically opposed to the old system, under which "training" frequently resolved itself into a contest, the brute force of the horse on the one side and the brute force of the man, assisted by mechanical appliances, on the other.

When the idea of utilising the animal's strength against itself first dawned upon me, I accomplished it by shortening the stirrup leather and tying the horse's head round towards the stirrup iron—thus causing the animal, when moving, to revolve until it became more or less giddy. But experience taught me that this elementary process was inadequate to meet all requirements; the supplementary use of the "third hand," and other details, suggested themselves to me in the course of practical experiments, until ultimately I elaborated my present system, which has successfully stood the test of over thirty years (1908), and which I will explain as lucidly and concisely as possible.

The "Galvayne" position is attained by tying the animal's head round with the halter shank, or the "Galvayne" strap, to its tail.

It may occur to the reader to ask how he is to approach sufficiently near to the quarters of a wild colt to enable him to perform the above operations without running the risk of being kicked. There are several ways by which it may be done in safety. The first method, which should always be adopted, is to take hold of the halter, say with the left hand, near the head, and swing the animal round and round sharply several times by pulling its head towards you and simultaneously pushing its quarters away with your right hand, ultimately seizing hold of the tail and continuing the process, making yourself the pivot round which the horse revolves, causing the animal to become giddy.

With a long-tailed colt it is not even necessary to push the quarters at all. There is no difficulty or danger in grasping the long tail, after pulling and holding the head round, and using it as well to swing the animal round.

The second method is to blindfofd the near-side eye (as you are working on that side) by slipping a soft felt hat under the cheek of the halter, totally covering the eye. If the animal resents the treatment and kicks, it will, instead of kicking at you, kick out straight behind; or, in any case, as you have its head held round towards you with your left hand, the kick will be directed away from you. Moreover, the fact that the full length of your right arm is between yourself and the horse's quarters constitutes a further guarantee of personal safety.

I may here mention that the "Galvayning" must always be practised in a suitable ring, about 45 feet in diameter, or in an enclosure fenced with hurdles.

While the colt is dizzy from being swung round and round, make an ordinary tie-knot in the tail, divide the hair above it, and pass the strap

through the division. Then pull the strap quietly and slowly until you have brought the horse's head round to an angle of 35 or 40 degrees, or to one that will compel the animal to turn round and round, almost upon its own ground (see Fig. 3). Then fasten the strap (without twisting it) quickly (you may have to do this whilst the horse is actually turning) by a slip-single-bow-knot to the tail.

Stand back and give the animal room to turn, so that you can judge by its movements whether you have done your work correctly. If the angle at which you have tied the head be too acute, the horse will revolve too quickly. On the other hand, if the head be comparatively straight with the body, it will not turn round at all, but will probably succeed in forcing its head sufficiently straight to go right away; should it effect this you must move smartly in front of it and catch it, and at once tighten the strap. If

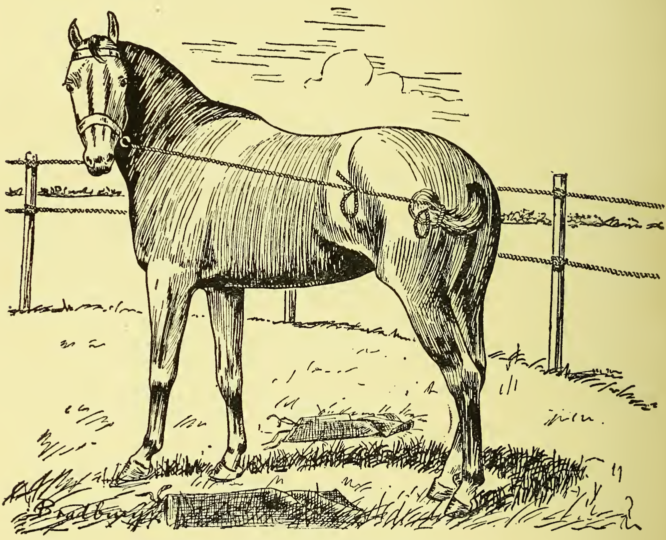


Fig. 3.—A Colt in the "Galvayning" Position.

it has been necessary to blindfold the animal on one side with a cap, you must *snatch* the latter away the moment after you have tied the strap, and *before* releasing the horse. When released it will turn round and round, eventually staggering slightly and coming to a standstill. If the angle at which its head has been tied be too acute, it may revolve so quickly that it will become dizzy and lie down, but you may prevent the latter by jumping in as its head comes towards you, and slackening the "Galvayne" strap, thus allowing the head more freedom and lessening the rapidity of the revolutions. Even if the animal should stagger down, the position in which it is tied will prevent the possibility of injury, always providing that the ring be on soft and suitable ground, for it does not really fall in the ordinary sense of the word, but merely staggers through dizziness, and lies down without any violence or harm whatever. To enable it to rise, it is generally

necessary to untie the "Galvayne" strap, and this is easily effected by pulling the loose end which hangs from the slip-single-bow-knot. It is absolutely necessary to adopt this style of knot when tying the "Galvayne" strap, as alterations and adjustments have to be rapidly effected from time to time, and this knot is the only one, so far as I know, which meets all requirements.

It will perhaps be advisable at this stage to describe more explictly the kind of enclosure best adapted for the breaking operations. A hard yard, irrespective of size, is not suitable. Neither is a small yard, if it be surrounded by a wall, as the animal may strike its head against the wall when turning, and receive serious injury. The most suitable place is a ring, pitched on soft ground, in the corner of a field, encircled by two ropes, or a fenced ring with sufficient bush all round the inside of it to prevent the horse from striking the fence when turning round or falling. In the case of shod horses, the shoes on the hind feet must always be removed during the operations, to prevent possibility of injury to the coronets through overtreading.

Once you have got the colt properly "Galvayned," watch it carefully for a little while before proceeding further, to ascertain the kind of temperament you have to deal with. If a nervous or excitable subject, it will "take more out of itself" in five minutes than a stubborn or sulky one will do in an hour. With an animal of the former class you must modify your treatment by handling it very calmly and quietly, refraining from the use of loud exclamations and from cracking the whip, generally speaking, from increasing its agitation in any way. With a stubborn animal the case is different. In fact, it is sometimes necessary to actually use the whip to make it move at all. The whip, however, should never be applied to the body, but only on the legs below the knees and hocks, and gently on the outside shoulder, accompanied each time (without fail) by the command "Get up!" given smartly and authoritatively. After having taught the animal to obey this command, use the ordinary "click" to start it, at the same time giving it a gentle flick with the whip as directed, to expedite its movements.

The length of time required for the treatment of any particular colt depends upon the animal itself. Sometimes it is possible, after a *few minutes only*, to approach it and stroke it quietly with your hand without causing fear or resentment, whereas in other cases it may take half an hour or longer to produce a similar result. Condition, as well as temperament, has a lot to do with this matter. Before commencing the operations, care should be taken to see that the subject is in fair fettle. It ought not, however, to have a full stomach at the time.

When the animal has sufficiently settled down into a state of docility and obedience, procure a "third hand" (the nature of which is fully explained in the "Explanation of Terms," etc.), and hold it so that it will come gently in contact with the colt's nose each time the animal turns round. Continue to hold it in that position until no fear or resentment is shown at it, when it is allowed to rest upon the colt's nose. Then commence to move the "third hand" gently up and down, until you can pass it quietly over the head and quickly on to the neck. This last action will probably be resented, and the colt will try to get away from the "hand," but as it cannot do this, it will commence to turn round and round more rapidly. Remain still until it has calmed down again, then approach it and commence to work as before. Keep the "hand" pointing above the horse's head, as close as possible without running the risk of striking it.

As soon as the animal has stopped turning round, replace the "third hand" on its neck, speak to it soothingly, and rub it gently with the "third hand" all over its neck and fore end, then along the back as far as the croup, as gently as if you were using one of your own hands instead of an improvised wooden one. As soon as the animal ceases to resent this treatment in any way, handle its hind-quarters, namely, below the tail, inside the flanks, on the legs (see Fig. 4), along the belly, etc., and ultimately under its tail, continuing to work the "third hand" about slightly all the time, to let the animal be aware that it is still there. During all these operations it is imperative that you "keep your temper." If the animal should strike or kick the "third hand" away, you must not retaliate in any way; simply replace it gently, but quickly, again and again on or adjacent to the particular spot from which it has been violently removed, until the colt ceases to kick it away. The "third hand" should

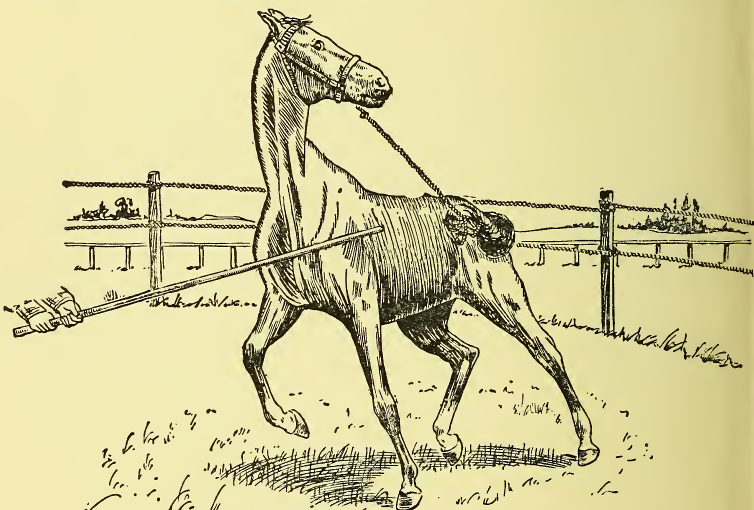


Fig. 4.—A Wild Colt when in the "Galvayne" Position.

be held in such a position that a kick will send it away from you, not in front of your body between yourself and the animal, or you may get hurt. The pole should be held firmly, and a stronger grip taken with the right hand at the moment it is struck, or, if the kick be a strong one, it may be knocked right out of your hands. In fact, I have seen one kicked with sufficient violence to send it through the top of a marquee. But you will generally be able to retain your hold upon it if you take a stronger grip with the right hand at the moment of impact. The blow will then only swing it round away from you, probably out of the left but not the right hand. Do not be discouraged if the subject persists in kicking for a considerable time. Continue the treatment until it ceases to do so. The "kick" was in the animal, although it may have been dormant, and it is best to provoke it and then eradicate it finally in the above harmless manner, in the earliest stages of training.

When the animal can be touched anywhere with the "third hand" without causing it to flinch, procure an empty corn sack, fix it upon the end of the "hand" by thrusting the pole into it, proceed as in the first instance, when using the pole only. Induce the animal to place its nose on the sack, then move the latter up and down a little, slowly and near to the face, ultimately raising and passing it over the head, and letting it fall gently on the back, just where the saddle should come. It may at first resent this, and kick or try to run away. But its efforts to escape will be quite futile. Whilst it is turning round, hold the "third hand"—the empty sack being suspended from it—in such a manner that the sack will come into contact with the animal's head every time it turns. It will soon become apparent to the colt that the (at first) terrible object which meets it at every turn is perfectly harmless, and its fear will quickly disappear. Continue to lift the pole up and down, slowly at first, then with increased speed, causing the sack to touch the animal at all parts; pass it down the quarters, and bring it against the hocks, quietly at first, then with a firmer pressure. If the colt kicks or removes the pole from any particular spot, replace it there or thereabouts until no alarm or resentment is shown. The "third hand" may now be dropped, and the sack taken off, to be used in conjunction with a second sack. Take one sack in each hand, and flap them both gently all about the animal's legs, head, and body, on both sides. Throw them on its legs, first quietly, then with more force, but always taking care not to hurt it. Continue this until you could, if desired, throw a hundred sacks on and about it without causing the slightest alarm.

I may say here that I believe the "*Galvayne*" *position to be the only one in which it is possible to place a horse which allows it the necessary liberty to show its vice at any period of its training, yet at the same time so restricts its movements that it is impossible for it to get away from you.* It enables you to teach and tame the animal in perfect security, both to it and yourself. If it fights—let it fight. It will rapidly subdue itself, and soon discover that it is perfectly useless to rebel. If it tries to rush you it cannot do so, as it is compelled to go in an opposite direction to the one in which it desires to go, whilst you, of course, move the other way. If it strikes or kicks, it merely hits the "third hand," not your own. The constant replacing of that which provokes the kick gradually makes it realise, first, that it is not in its power to evade the object which is so annoying in the first place, and, secondly, that the object itself is perfectly harmless after all. The empty sacks flapping and falling all about it, and on it, prepare it to take harness, and also to see and feel a rider on its back. In fact, during the process of "Galvayning," etc., you have not been merely training and gentling it, but you have also been educating its most important senses—seeing, hearing, and feeling. The senses of sight and hearing require further training, of course, and the "Galvayning" position is the best and safest for the purpose, particularly in the case of a nervous and excitable animal which it is desired to train to strange and terrifying noises and objects, such, for example, as a traction engine or a motor-car.

When "Galvayning," keep the animal circling round the enclosure in one direction only during the whole of the time. To ensure this, you should place yourself in a position about the length of your whip from the moving animal, and nearly the same distance from the fence or ring ropes, remaining in the same relative position as nearly as possible throughout the proceedings. If the horse is too close to the ropes, get it away from them, by going between them and the animal. If the animal be "Galvayned" on the "near" side, the trainer must work on the "off"

side, and give way (stepping backwards) when its head is coming towards him, and move forwards as its head leaves him; by working on this system, the horse can readily be moved in any direction.

Continue to throw sacks all over and against the colt—except its face—roughly, until it exhibits no resentment or alarm; then go round to the off side, and take firm hold of its mane with your right hand; put your left hand over its wither, the remainder of your arm, as far as the elbow, resting on its back. Lean upon your left elbow, pull the mane with your right hand until you are in a leaning position upon the colt's back, then draw yourself quietly off the ground, thus bringing your weight to bear upon the animal for the first time (see Fig. 5). The preliminary practice with the empty sacks will already have accustomed it to see objects on its back, and you have

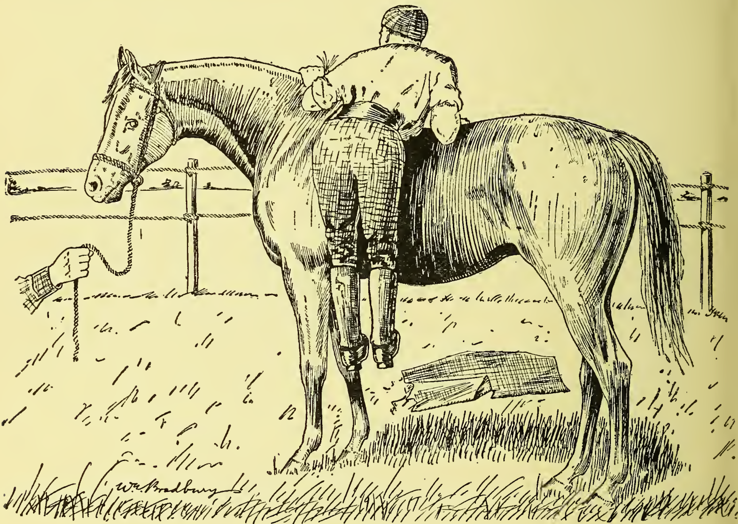


Fig. 5.—The Correct Position when Mounting a Colt.

Note.—If mounting on the off side, the right hand grasps the mane, and the other movements are also reversed.

now to familiarise it with the sustaining of a weight. Under the unaccustomed pressure it may turn round a time or two, but maintain a tight grip of its mane and remain quietly where you are. You will be perfectly safe, and as soon as the colt is calm and motionless, lift yourself on to your hands (see Fig. 6), and throw your left leg neatly over its back, at the same time withdrawing the "Galvayne" strap out of the tail or tail-cord; turn the animal once or twice by pulling its head round, and at the same time gently tap it on the outside elbow with the side of your foot. The turning round tends to distract its attention somewhat from the unusual weight upon its back. Allow it to stand still for a short time, petting it and making much of it in the meantime; but avoid fidgeting about on its back while doing so. After a few minutes' rest, if necessary, give the colt another sharp turn round, then let it stand still and pet it again. After-

wards let your assistant lead it straight away for a few steps, then round about for a few minutes, again stopping and repeating the petting.

The next step is to accustom the colt to see the rider mounting and dismounting, and moving on its back. Commence by throwing your right leg over as if to dismount, but do not actually alight upon the ground; simply allow your body to lean against that of the colt, supporting yourself upon your hands and arms, as shown in Fig. 6. Raise yourself by straightening your arms, throw your right leg smartly over its back again, and you will be astride once more. Now repeat this partial mounting and dismounting on the off side and keep on with the exercise—taking each side alternately—as long as you may consider necessary. Finally dismount entirely, by sliding down quietly—first on one side and then on the other—to the ground, keeping as close to the body of the colt as possible until you are on *terra firma.*

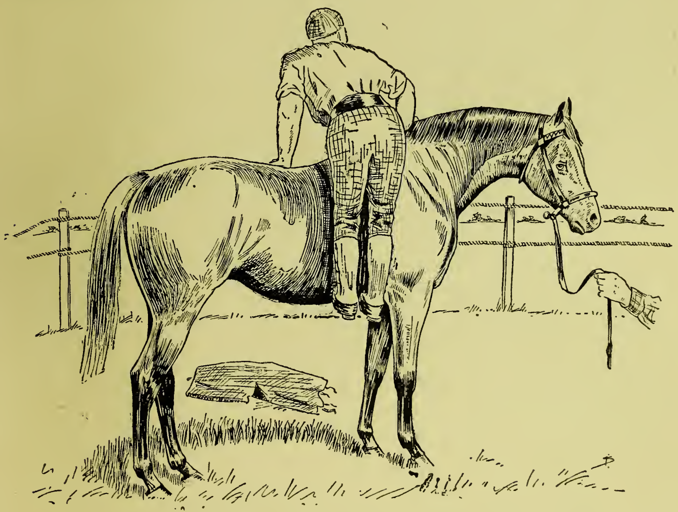


Fig. 6.—Second Position when Mounting a Colt, either on near or off side.

The correct way to mount from the ground is to grasp the mane firmly with one hand—the left hand if mounting from the near side, and *vice versa*—and the wither with the other; then spring up on them until your body is nearly in an erect position on your hands, and smartly and cleanly throw your leg (the right one if mounting from the near side, of course) over the animal's back. Practise this complete mounting and dismounting from both sides as frequently as may be necessary to thoroughly familiarise the colt with the proceedings. It is best to practise on a quiet horse at first, and anyone should be able, by carefully following the above instructions, to acquire the art of mounting and dismounting with neatness, precision, and safety, within a very short space of time.

After finally dismounting, give the colt a rub down with a cloth and dandy, and another spell of fondling and petting. Then, either tie it up

with the hair rope on, being careful to wrap the part that goes under the tail thickly with a chamois leather or piece of soft rag, or else put on the surcingle and crupper, and give the colt a few swallows of water. The animal will be in need of a spell by this time, as it will have undergone a considerable amount of unusual exertion. Never, under any circumstances, overtax its strength, or you may convert a good-tempered animal into a bad and sullen one, and make a naturally bad one a great deal worse.

Note.—The whole of the foregoing training and taming, up to the act of mounting, can, as a rule, be executed in thirty minutes,—this, of course, does not include the catching of the colt or putting the swinging and leading rope on,—which, as I have stated, need *not* be done in the first stage of its breaking, as "Galvayning" comprehends *leading*, and few colts require special instruction in this respect afterwards.

Bitting a colt the first time.—The best all-round bit to use is a stout-jointed bar snaffle, either with or without keys. For some colts a stoutish half-moon snaffle with keys; while for others a straight sliding bar snaffle may be preferable—but no thin bits of any kind. To make it difficult for the colt to acquire a habit of putting its tongue over it, the bit should be placed well up in its mouth at first, then afterwards gradually lowered to just above the tushes, or in fillies' mouths about from 1 or 2 inches above the corner incisors. The side bars on the bit materially assist the colt when learning to turn with the long reins. Care must be exercised when bitting a colt, which should be done as follows: take hold of the poll-piece of the bridle with the right hand and open the colt's mouth with the left, and draw the bridle upwards with the right hand and the bit will be brought gently and quickly into the mouth without creating annoyance or fear. Test the fit of the bridle by pulling the cheek straps downwards, and note that the bit is in the correct position.

Mouthing, bending, and manipulation of the long reins teaching the colt to obey the bit.—The great object of correct mouthing is to preserve, instead of diminishing, the natural sensitiveness of the bars of the animal's mouth, and for this reason the question of the kind of bit to use is one of the greatest importance. Any kind of bit may slightly excoriate the lips of the colt and the bars of the mouth, but an unsuitable one will produce deep sores and pronounced bruises, rendering this portion of the animal's training unnecessarily painful, and also "spoiling" its mouth instead of "making" it. The inevitable result of repeated sores—real sores, not the slight abrasions that we must always expect on the bars of the mouth—is that they become callous and non-sensitive in precisely those parts where acute sensitiveness is most essential in order to train the colt to be amenable and obedient to the slightest action of the bit. The use of a heavy, ponderous bit is also a sure method of ruining the mouth of the animal.

I advocate the use of running reins for various important reasons. Firstly, they only permit the colt to turn its head from side to side, or to dip its mouth inwards and towards its chest, in other words, to "bend to the bit." This is exactly what you are endeavouring to make it do. Its only means of relieving itself of an unpleasant strain is to do what is right. Secondly, the running rein prevents the animal from putting a greater pressure upon one side of the bit than upon the other. Thirdly, it prevents the colt acquiring the habit of "boring," it being out of the animal's power to thrust its nose forwards and downwards. Fourthly, the running reins do not give the animal a chance of leaning or "sulking" on either

rein—a bad habit, which makes "mouthing" impossible and frequently develops downright stubbornness.

Having put on the surcingle, tie a rein of cord to the lower ring on the off side, pass it through the bit and back through the upper ring and a top ring, to the upper near side ring; thence through the bit, fastening off by tying a slip-bow-knot on the lower near side ring: pull it so that you will know it will run fairly easily (see Fig. 7). Do not fix the cord tightly, but simply so as to cause a very slight pressure only on the mouth. The object of this is to reduce to a minimum the natural inclination of the colt to resent and "fight the bit"—a frequent cause of future 'bad temper." When the animal is thus bitted, stand behind it with a long light switch-whip and gently encourage it to advance and face the bit, instead of backing, which nearly all colts are inclined to do at first.

When the colt will face the bit readily and strongly, the rest of the

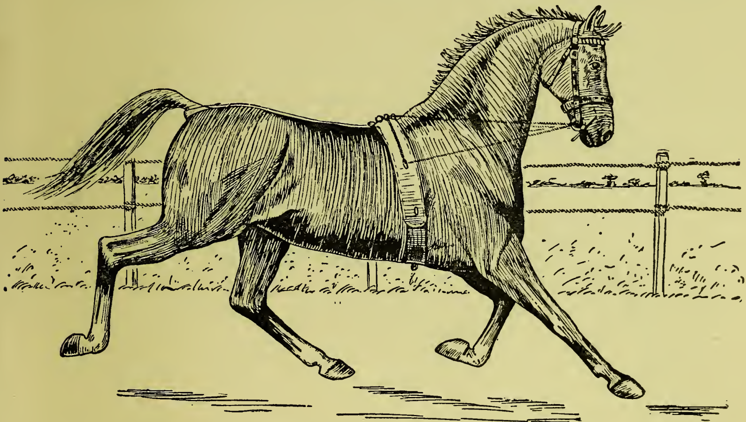


Fig. 7.—The Colt being exercised in the Ring with Running Reins on, by Control of the Whip only.

breaking harness may be put on, provided the mouth be free from tenderness and excoriations. If the intention be to drive the colt in a winker bridle, the latter should be put on after the surcingle and tackle have been adjusted, so that the animal may see all the proceedings. But, as a matter of fact, the use of winkers at all is entirely optional. The breaking can be effected equally as well without as with them. The long reins should be passed through the lowest ring on each side of the surcingle, and buckled to the bit (see Fig. 8).

Occasionally a colt shows a disposition to carry its head too low, in which case an overhead check must be used. An improvised one consisting of a doubled cord will answer, passed through the first ring on the top of the surcingle, carried up over the pole through the loop between the ears on the head collar, twisted so as to prevent it from touching either of the eyes, fastened to each side of the bit, and secured at the exact length requisite to enable the colt to get its head in the desired position and no lower, will suffice.

Some colts acquire a habit of throwing their heads violently up and down, a habit which rapidly becomes confirmed and is very annoying, and even dangerous afterwards to the rider. In such a case, a martingale must be used in conjunction with the overhead check. The best form is a "standing" martingale for this particular purpose, namely, one direct from the surcingle, passed through a loop on the breastplate, and buckled to each side of the bit. The ends should be so holed as to enable the breaker to adjust the length to a nicety.

As "Galvayning" is the keystone of my system of taming and "gentling," so is the scientific manipulation of the "long reins" in the ring the keystone of my system of training—the real object of which is the inculcation of the habit of prompt and absolute obedience to the bit and reins. My experience has taught me that the only method by which this can be accomplished is by the scientific handling of the long reins.

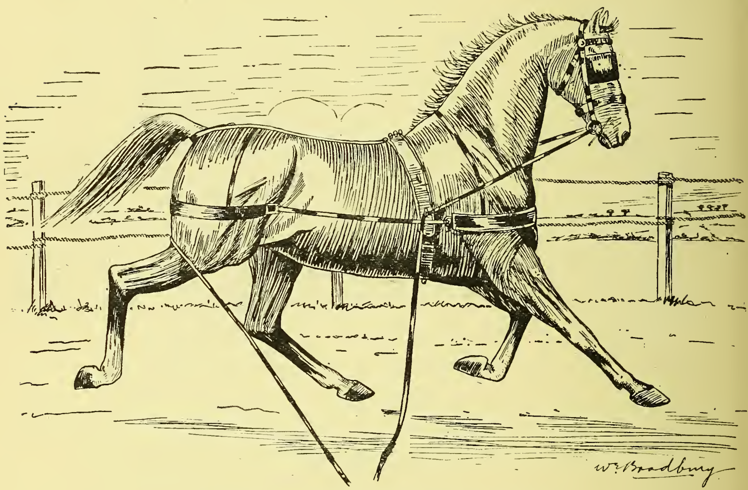


Fig. 8.—The Colt being taught to obey the Bit.

I am not ignorant of the fact that two long reins of a kind have been used for a number of years in training operations, but the scientific and correct method of using them was not practised or known until I introduced it in Australia, and subsequently into Great Britan. It is impossible to emphasise too strongly the value of the long-reins treatment. It is the most potent factor in training generally, and the most efficacious in the prevention and treatment of the many kinds of "bad mouthing," which may be rightly said to be, as far as horse vices are concerned, the *root of all evil.* "Bad mouthing" is solely responsible for the production of confirmed "bolters"—horses that, under the influence of the least excitement, become uncontrollable. It is also largely responsible for "jibbers"; those addicted to this vice invariably decline to obey the rein (in consequence of bad mouthing) before refusing to pull. Again, in the case of those horses which kick only when brought abruptly to a dead stop,

while being driven at a smart trot in a vehicle, and of those which only kick if suddenly stopped with the reins in the ring during the process of training, *this* habit of kicking is also frequently attributable to incomplete and bad mouthing. It is the animal's method of expressing its resentment of a forcible and unusual operation of the bit.

Now, inoperative and bad mouthing is, in the great majority of cases, the direct result of the old system of training the colt to obey the bit. Many of my readers have doubtless observed this system in operation. It consists of attaching two separate ropes to the bit, one on each side, and, as a rule, allowing some ignorant (ignorant, *i.e.* of colt breaking) yokel to parade the animal along a country road. From time to time, the said yokel spasmodically jerks and drags at the horse's mouth in the most senseless manner, now and again varying these proceedings by striking the animal with a swinging action of one of the ropes as violently as possible on its quarters, following this act by hanging with his whole weight on to both ropes, thus compelling the colt to pull him along with the bit. I have myself observed this idiotic process in operation on many occasions, when driving about the country. Is it possible to conceive of a more effective and drastic method of utterly destroying the sensitiveness of the animal's mouth, and of thereby rendering it completely callous and impervious to any ordinary pressure of the bit? Surely it is not necessary to say more in condemnation of this preposterous system.

On the other hand, the long-reins treatment is specially adapted to develop, instead of destroying, the natural sensitiveness of the bars of the mouth. It enables the pressure of the bit to be modulated to the nicest possible extent. Moreover, it ensures a perfectly even pressure on both sides of the mouth, thus preventing "one-sidedness," and gives the driver absolute control over the horse at all times and under all circumstances. Another advantage of the long-reins system is, that it enables the training to be effected within the circumscribed area of a ring, or other suitable enclosure, and, if desired, under the immediate supervision of the owner, whereas one of the chief recommendations (or the reverse) of the old system is that it affords, to the yokel in charge of the "training" operations, ample opportunities for attempts to satisfy his unquenchable thirst at the wayside inns.

I have said enough to indicate the importance of mastering the use of the long reins to all who desire to become experts in the scientific treatment and training of colts and horses. The process of learning the use of them is by no means tedious or laborious. A few hours should suffice to acquire dexterity, and the time will be exceedingly well spent. It is advisable to commence by practising with a "made" horse, of a not too sensible or excitable disposition. With these preliminary observations, I will now proceed to describe the process in detail.

For convenience' sake, and to faciliate explanation, I have referred, and shall continue to refer, to the "reins," but, as a matter of fact, it is one long rein only which is used. It should be a continuous leather one, from 40 to 45 feet in length, about 1½ inch broad, and stouter towards the parts adjacent to the mouth of the animal.

It is necessary that it should always remain flat, so as to facilitate its running through the fingers when the horse is being turned. There should be no buckle in the hand part, for a similar reason, and to prevent injury to the hands of the driver.

Take the reins in your left hand, passing the left rein through the hand, or rather across it, from left to right, and the right rein from right to left.

This is the "Colonial" or "Yankee" style of holding reins, and is undoubtedly the best to adopt for ring work.

You will now take up your position near the centre of the ring, and parallel with the horse, *i.e.* facing its side. The inside rein will now be in a direct line to you from the ring in the surcingle, at right angles from the horse's head, whilst the outside rein will pass along the animal's farther side and round its quarters—just above the hocks—to your hand, as shown in Fig. 8. Start the animal at a quiet walk, and let it complete the circuit of the ring, yourself always occupying the centre of the ring and moving gradually with the colt, so as to be always parallel with it and facing its side. When the circuit of the ring is completed, give the command "Right turn!" assuming the horse to have been sent to the left at the start, simultaneously putting your right leg well forward, planting your heel well into the ground, holding the rein firmly, and pulling the animal round, allowing the left rein to slip through the hand. Directly the horse has turned sufficiently, close the left hand tightly on the rein, to prevent the animal from turning in towards the centre of the ring; re-grasp both reins firmly, taking hold of them with the right hand—the left hand holding the left rein at a distance of about a foot from the right hand —and, when about to turn the horse to the left, run the left hand to the same position as it occupied before the turn; give the command, "Left turn!" throw out the left leg, planting the heel well into the ground, and taking a firm hold of the rein; pull the horse round, allowing the right rein to slip through the hand until it has turned "left about," then re-grasp the rein firmly with the right hand to prevent the horse from turning in too far, and again take hold of both reins with the left hand, the right hand being on (but not grasping) the right rein about 12 inches from the left hand. Continue this exercise, first at a walk and then at a trot, turning the horse after every complete circuit of the ring, until you can manipulate the reins with adroitness and ease.

If the animal you are training with the "long reins" (after your preliminary practice with the "made" horse) be a colt or a hard-mouthed horse, you must gently flick its inside shoulder (the one always next to you) with your whip when first teaching it to turn (a long, light, drop-thong whip is the best to use in the long-reins treatment). In the case of a colt always use a bar-snaffle—the bar eases the mouth and prevents injury. For the hard-mouthed or runaway horse, use a four-ring jointed snaffle.

When using the word "Whoa" to stop the colt, do not be afraid to speak too loudly. Let the command be made with decision, and impress upon the animal that you mean to be obeyed by first slackening the reins somewhat and then standing still abruptly yourself, allowing it to "go on to the bit" simultaneously with your ejaculation of "Whoa." Do not pull back at all—simply keep your arms slightly bent and rigid—being careful to grasp the reins tightly at the right moment. If the animal refuses to stop, repeat the exercise until it will do so. Less than a dozen "stops" will generally accomplish this so effectually that it will stop immediately, even by a whispered "Whoa!"

To teach the animal to "back," let your assistant take the reins and stand behind the colt, whilst you go to its head. When you are both in position, and ready, say "Back!" your assistant making a strong, steady (but not violent or jerky) pull at the reins, while you simultaneously put your left hand on the animal's nose, but not in such a manner as to interfere with its breathing. If it should be stubborn, put your right hand as well on its near shoulder, giving it a backward push with your left hand

and a sideways push with your right, simultaneously with your ejaculation of "Back!" Never make, or allow, the colt to run backwards indefinitely, or it will be very liable to develop a tendency to run backwards every time it is stopped—a very awkward habit, and one that is sometimes troublesome to cure. Simply make it to go back two or three steps at a time, and stop directly the pressure on the rein is relieved. It must also be taught not only to stop when ordered, but to remain perfectly still upon the very place indicated. No fidgeting about or turning a little to one side or the other must be tolerated. Should it show any tendency in this direction, it must be promptly "straightened up" with the whip and reins, and compelled to return to the spot where the command to "Whoa!" was first given. The reins must not, however, be used for flapping purposes. Only two "Whoas!" should be given, namely, the one it did not obey and the one it was made to obey. I strongly advocate that all animals should be

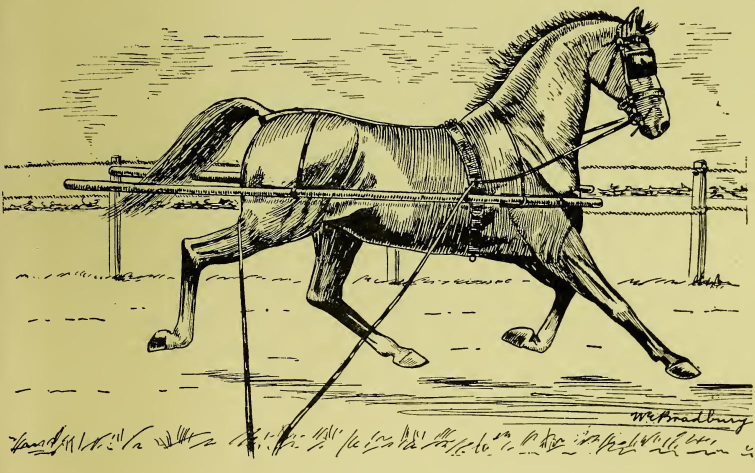


FIG. 9.—Training the Colt to "Shafts."

trained in the ring without winkers, in the first place. The use of open bridles facilitates the training in every way, both for the man and the colt.

The sense of hearing also undergoes a certain amount of training during the whole course of the driving lessons in the ring, materially assisting the trainer in his future operations. As time goes on, the "Whoa!" need not be given so loudly, but it must always be given smartly. When the animal is perfectly trained to obey the bit, words of command may be discontinued with the exception of the word "Steady!" indicating that the horse is to remain still. This is entirely distinct in meaning from the word "Whoa!" and its use must be continued for a longer period. In fact, it may be used at any time in the future, when necessary to make the animal remain motionless. It should have the same signification to the trained horse as the word "Attention!" has to the drilled soldier, namely, that he is not to move until ordered to do so.

The value of treatment on the lines indicated, if intelligently and carefully carried out, cannot be overestimated, and will be apparent throughout the whole course of the training. But I must again remind the would-be trainer that a few hours' preliminary practice in the ring with quiet or "made" horses are essential before tackling the raw material. Otherwise, in place of properly "mouthing" and training the animal, the opposite result may possibly be attained. It is hardly practicable for anyone to train a colt and teach himself how to do it simultaneously.

No system of "mouthing" can be properly described as efficient unless it enables the driver or rider to retain absolute control over the animal when it is labouring under excitement. To test the thoroughness of your work, therefore, put the horse or colt into a state of considerable excitement by cracking your whip as loudly as possible, throwing an empty sack or two

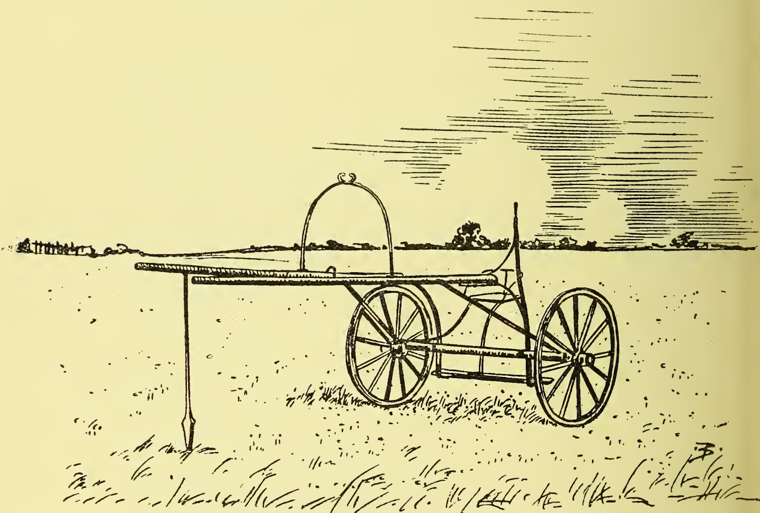


FIG. 10.—The Author's Patented Single Skeleton Brake.

on its back unexpectedly, or doing anything, in fact, calculated to frighten it and cause it to bolt. If, under these circumstances, you find that you can control it perfectly with the reins, you may rest satisfied with your efforts. It may just be noted here that *bad-tempered* animals invariably resent being made to "back," and a thoroughly good drilling with the long reins in the ring is absolutely essential for them.

The end of the traces should have been passed through the breeching rings and fastened off. Now they can be tightened up somewhat so as to bring pressure upon the breeching and breastplate or collar, which teaches the colt to pull at the same time and learn the use and feel of the breeching. Two of the poles, or third hands, can be tied on to the harness (see Fig. 9), thus emulating shafts; after a turn or two round the ring, some kind of noise can be made—first in front of the colt—then directing the assistant making the noise to walk on, causing

the colt to follow the noise—a couple of tins with stones in each will do—then rattle them behind the colt when going round the ring and also when standing.

This training to noise only occupies a few minutes, when, if the colt displays no fear, bring the brake up behind and close to the colt, let the assistant rattle the brake, dropping the shafts down, etc., so as to let the colt know that something is behind him. Harness the colt in such a manner—noisily—if I may express it so—so that the rattle of the wheels will not frighten it (see Fig. 10); reattach the strap to the head collar, let the assistant lead the colt, and you get into the trap and drive,—a field for this is best or a large level yard. The colt should be driven some time before taking it on a high road (see Fig. 11).

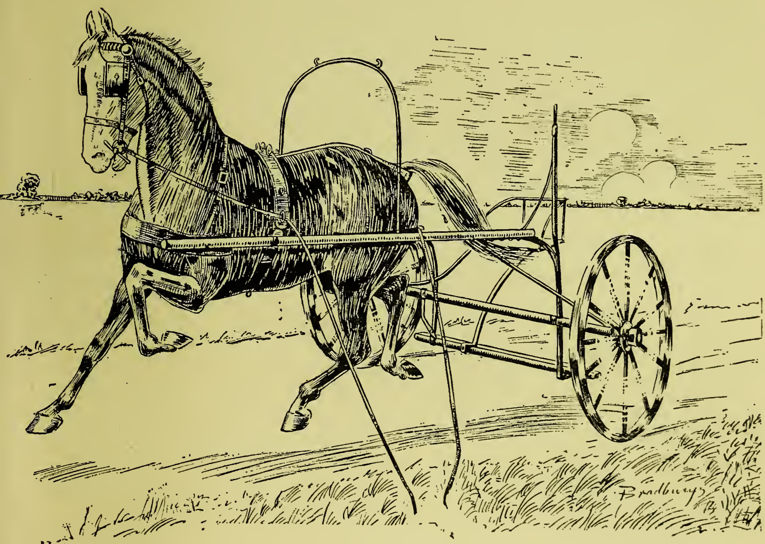


Fig. 11.—Training the Colt to manage a Vehicle.

Note.—If breaking the colt only to saddle, after the termination of the training with the long reins, the colt can be saddled and bridled, using a bar-snaffle bit, mounted and ridden round the ring, turning left and right, in and out, stopping occasionally; this can also be repeated in the open field, providing the colt is not tired out.

Careful obsevation of the condition of the animal must be made from time to time, and if the colt becomes tired and exhausted the lesson must be terminated at whatever stage the colt shows symptoms of fatigue. If the colt is a strong one that has been well nurtured, it will, if the breaker is careful, be able to go through the entire training to saddle or harness in one lesson. The driving or riding to be repeated afterwards daily. Great care must be taken not to cause tender or sore shoulders, girth or saddle

galls; a dressing on these parts of strong salt or alum and water immediately on returning from exercise will materially assist in preventing these excoria-

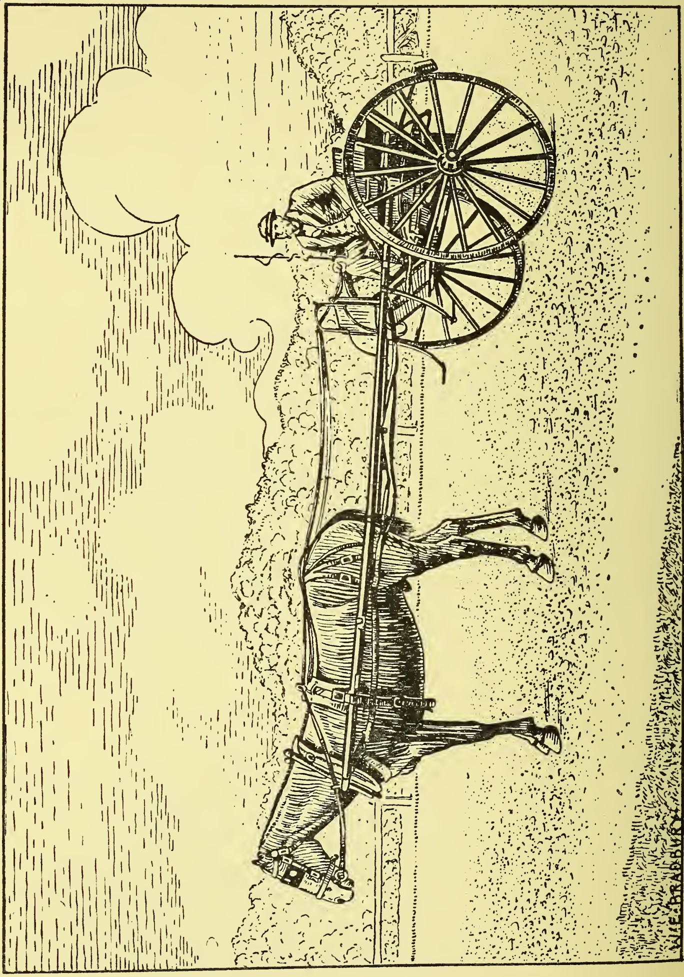


Fig. 12,—The Author's Long-shafted Exercise Brake.

tions. Where many colts are being broken, the long-shafted brake (see Fig. 12) will be found most useful.

Explanations of various terms and descriptions of special appliances used by and can be obtained from Sydney Galvayne, care of Messrs.

Baillière, Tindall, & Cox, 8 Henrietta Street, Covent Garden, London, W.C.:—

Galvayning . . .	Tying the head to the tail.
Galvayne strap . .	The strap used for the above.
Third hand . . .	A smooth, round hickory or ash pole, 10 feet long, 1½ inch in diameter, with rounded ends.
Hair rope . . .	A specially made rope, about 14 feet long, having horsehair interwoven in it; small loop one end.
Galvayne head collar .	A special collar, designed and used by the author.
Galvayne surcingle .	A special surcingle invented by the author, and forming an essential feature of his system of training and breaking.

Horse Shoeing.—This ancient art in former times occupied an exalted position among the handicrafts, and the armature of the horse's foot called for the surveillance, if not the operative skill, of a high officer of State. The mareschal performed a function of profound importance, when the progress of king, courtiers, armies, and all who were borne from place to place depended on the main motive power then existent, but which is now being supplanted by other forms of force. Though the practice of the art may not now be deemed worthy the consideration of such exalted officials, it is only because the craftsman is more easy of access, and more to be relied on than formerly. The use of the horse for purposes which he has been called on to perform for many years continues, and much importance still attaches to maintaining man's most faithful servant in an effective condition. The axiom "No foot no horse" is as true to-day as a thousand years ago, and his efficiency largely depends on the manner in which he is shod.

The action of our Technical Education authorities in providing classes for practical instruction, and of agricultural societies in instituting competitions in this branch of the blacksmith's art, have awakened an intelligent interest not only in the mind of the shoer, but in that of the owner and user, and there is no room to doubt that now the principles of proper shoeing are more generally understood and applied in practice than at any previous period. The horse-shoer of the present day is a reasoning and reasonable creature, and free from many of the prejudices of his predecessors in the craft, which had become a byword.

The horse shoe has been dubbed a necessary evil, though the necessity for shoes on horses has been keenly disputed, and many experiments have been made in working horses without shoes. A small proportion of horses with perfect feet and true action are quite able to dispense with the shoe, but many trials prove that the great majority of our horses' feet fail to withstand the artificial conditions of our roads, and the exigencies of having to go exactly how, where, and when man may direct.

It cannot be too forcibly impressed on our minds that the sole object of placing iron at the bottom of the horse's hoof is to protect it from undue wear and injuries causing splitting and chipping of the wall. The aim of the shoer should be to apply this rim of iron in such a manner as to cause the smallest possible deviation from the natural bearing. The making,

fitting, and fixing of horse shoes is, however, no mere rule of thumb. Each individual foot requires special treatment and exercise of the workman's skill, but this must be in an attempt to leave the bearing of the foot as near as possible to what it would be in the natural unshod state, and under ordinary circumstances not in an attempt to improve on nature by adaptation of some particular fancy for the good of the horse. In this connection it must not be forgotten that horses under domestication are subjected to many conditions which are purely artificial, that there is much variation in the shape of the foot, the quality of the horn and in some cases even deformity, so that occasionally it may be absolutely necessary to modify hoof and bearing.

An intimate knowledge of the minute anatomy and complex physiology of the structures of the foot is by no means essential to good shoeing, though a general knowledge of the parts of the foot, the disposition of the horn and particularly of the extent of and functions performed by the horny structures, is most desirable for everyone who shoes or directs the shoeing of horses.

The horse's hoof and the structures contained within it correspond roughly to the human nail, and that part of the finger and toe covered by it. The nail is analogous to the wall of the hoof, and the heel of man to the point of the hock, so that when one hears of the analogy of the tight boot and the tight horse shoe, one may conclude that the comparison is fallacious. The horn itself is not sensitive, though it may be the medium by which impressions are conveyed to sensitive parts which it covers. Ordinarily, it preserves them from painful or disagreeable impressions. It is also a poor conductor of heat. The horn grows at a rate which may be roughly gauged by the knowledge that a new hoof is produced about every year.

Within the hoof are the *pedal or coffin bone*, which occupies most of the space, the *navicular*, a small bone placed behind it, and part of the *coronet* bone, whose lower surface rests on the upper surface of the pedal and navicular bones. Over these bones is a network of small blood vessels, as it were, like a glove drawn over a finger. From these blood vessels the horn is secreted, while around the foot, that is under the walls and bars, they are arranged like leaves or laminæ, which dovetail into horny leaves on the inner surface of the horn, and so serve to hold the hoof in position. Under the sole and frog the arrangement is a little different. These parts correspond to the quick of the human nail, and are highly sensitive. The horn of the hoof is divided naturally into parts, and named for purposes of description, wall or crust, bars, sole, and frog.

The *wall* is the horn visible from the front and sides when the horse's foot is on the ground, at the back it curves in on either side to form the *bars*. The horn of the wall and bars are produced from the blood vessels around the coronet. The wall is thicker on the outside than the inside of the fore foot, while in the hind foot it is usually thicker at the sides than at the toe. Injury to the coronet may interfere with the formation of the wall or bars. The effect of such injury is often observed on the inside of the fore foot, and in the front of the hind foot in the form of "sandcrack." If the injury is severe or the damage extensive, the hoof may be very defective below, a condition known as "false quarter." The horn of the wall tends to grow in a downward and forward direction, and if it is preserved from wear and not cut for a year or two actually turns upwards at the toe and assumes the form of a hollow cone, as neither the sole nor the frog horn is sufficiently coherent to proceed with it. When the animal is shod, there is, of course, no wear of the horn, and there is always a tendency for the toes to become too long. In the preparation of the foot for the

shoe, these matters are very important considerations, for the effects of the elongated toe are to throw strain on the back tendons and to increase the liability to trip and stumble.

The *horny sole*, which lies under the foot and between the wall and bars, is produced from the blood vessels immediately above it. When sufficient horn to protect the overlying parts and to bear its share of weight is developed, the oldest horn comes off from the sole in flakes.

The *frog*, developed from the vessels immediately above it covering the "fatty frog," is composed of much softer horn, tends also to peel off to some extent like that of the sole. It becomes what is termed ragged. It also protects the overlying sensitive parts, but, by virtue of its indiarubber-like consistency, it averts concussion, and by its relative softness and shape it aids the horse to "pull up" and prevents slipping. In order to preserve the proper consistency, size, and shape, and to perform its function, the frog should reach the ground and receive some degree of pressure from the weight of the horse. The ordinary hard, dry condition of this part of the horse's hoof results from its usually being so pared away that it takes none of the bearing which it is designed to do.

The object of attaching the shoe is to preserve these parts in their natural conditions by allowing each to perform its own particular duty. The old idea of "paring out the foot" to make it look a work of art, is responsible for a large amount of mischief, and has helped to ruin good feet innumerable.

The *preparation of the foot for the shoe* is the most important part of the operation. The *unshod colt* by his nervousness not infrequently prevents a good beginning, and the utmost gentleness and patience should be exercised, for the struggling restive young animal is not only liable to do himself and his shoer immediate injury, but to acquire habits which will render future shoeing dangerous and imperfect. The unshod foot will probably require removal of loose ragged horn. A comparatively thin shoe is best, and just as much of the under surface of the wall should be pared away as to allow the frog, whose loose horn has been removed, to come on to the ground. If the young animal has been on fairly hard ground the toe is usually worn back to proper proportions, indeed the general disposition of the foot is just what it should be when the shoe is on. If the colt has been grazing on soft ground, it may be necessary to remove a considerable amount of the horn of the wall, especially at the toe; while it is not an uncommon experience to find the wall so split and torn that the first shoe has to be fastened as best it can be. The rasp drawn across the foot so as to include the wall on the inside and outside is the best method of ensuring a true and level bearing, but occasionally the wall is so much overgrown that a cutting instrument is necessary. On no account, however, in horses of any age should the outside of the wall be rasped, except perhaps a spot with the edge of the tool for the reception of the "clinch" of the driven nail, as the natural product on the surface of the hoof helps to preserve its integrity, and should not be removed.

In preparing a foot for re-shoeing the same principles must guide us, the amount of horn removal necessary will depend on the previous treatment of the hoof and its individual peculiarities. If at the former shoeing too much horn was removed, very slight levelling with the rasp may be sufficient, while if the shoe had been on for a long period or an excess of horn left, a large quantity may have to be taken away, so that the proper bearing is attained. Attempts have been made to formulate definite rules for guidance. Thus it is laid down that if the toe of the foot is placed against a perpendicular object the angle formed by this body and the front of the

wall should be one of 45°; but many feet will not admit of this, and the shoeing smith or he who directs the preparation of the foot should possess an eye for the proper line of the horse's leg. The shoe must be made to fit the foot, and not the foot to fit the shoe.

The *making of the shoe* involves the skill necessary to adapt it to the prepared foot. The ideal shoe should have a flat upper surface for the under surface of the wall and a little of the outer border of the sole to rest on. This must be the guide as to the size of the shoe. There is no advantage in having any iron on which the horn does not rest. There is no harm in momentarily applying the hot shoe to the hoof in order to get an idea as to its shape. The hot shoe should, however, not be kept there long. The nail holes should be placed so as to allow the nails to be driven where the horn is most suitable to receive them and to afford a good hold. The most important consideration about nail holes is their direction. If this is towards the inside of the foot there will be a much greater liability to prick when the nail is being driven, and the smith who habitually punches his nail holes in this manner is to be avoided. Of course this misdirection of the nail hole can be overcome in the driving of the nail if it is recognised, but this does not always happen, the nail does not come out at the expected spot, and is withdrawn sometimes after having injured the sensitive parts. The iron of which shoes are now usually made comes to the smith in the form of prepared rods already "fullered," that is with grooves for reception of the nail-heads, at the same time being supposed to afford a better foothold. Much objection has been raised against applying a hot shoe to the horse's foot. This objection cannot be sustained if the shoe is held there a few seconds only, as it makes a level bed and a more perfect fit, which allows it to be nailed on more firmly and to remain on with less chance of nails becoming loose. On no account, however, should a shoe be nailed on before it has been thoroughly cooled. The hoof horn does not conduct heat well, and we have often noticed a red-hot shoe applied to a horse's foot and kept there much longer than we would have dared, and the horse evince no sign of discomfort.

The *fixing on of the shoe* requires care and patience, and a careless or impatient person is ill fitted for this work; a horse is easily lamed by a misdirected nail. The shoe should be firmly fixed and the nails well beaten in, but once well through the force of the hammer should be received on the head of the pincers used for turning down the clinch. It is much better to fix on the shoe with the horse's head loose than tied up, and the person who takes a horse to be shod should habitually stand holding its head during the operation—a rule, we fear, more honoured in the breach than in the observance.

Shoes should be removed at least every four or five weeks, and the feet brought down to their normal size and bearing. The overgrown foot is not only unsightly but injurious, especially as a cause of straining the tendons and misshaping the limbs. Many farmers and others in "a penny wise and pound foolish" spirit sadly neglect this removal of shoes and regular shoeing, and often greatly to their cost. At least 20 per cent. of the real value of a horse has often to be struck off for bad appearance of the feet and the results of neglect in this direction.

Many *varieties of shoes* have been introduced, and bear names beyond mention. The *Charlier shoe*, while providing protection against splitting of the wall, imitates more closely the natural state of the unshod foot than any other. It is a light narrow four-angled rim of iron, for the reception of which a groove is cut out of the bottom of the wall by means of a special

tool. The sole and frog are thus allowed to take their natural bearing, and the outer rim of wall is replaced by the shoe, whose lower ground surface is exactly where the lowest part of the wall would be on the unshod foot. Unfortunately the difficulties experienced in getting this shoe properly applied have prevented the general adoption of this plan, which has also been largely deterred by the fact that many animals have been lamed owing to non-recognition of the fact that the foot should have at least a month's extra growth before the grooves can be safely cut out without risk of injury to the superimposed sensitive structures. Many modifications of this system have been adopted with varying success.

The *seated shoe* has the outer portion only of its upper surface arranged to receive the bearing of the wall. It is used for healthy feet under the conviction that the wall only should bear weight, also in special cases as "pumiced" foot, convex sole, etc., in which bearing on the sole is contra-indicated.

The *bar shoe* is either an ordinary shoe with a piece of iron welded on to the extremity of the heels, or a circular shoe which takes the bearing of the frog. Such are often used when from some diseased state as laminitis the animal in progression puts the heel down first.

The *patten* is a shoe with a piece of iron under the heel, so as to raise this part and to allow of relaxation of the back tendons.

The *tip* is a more or less crescent-shaped piece of iron affixed under the toe. It is used sometimes as the working shoe, or for turning out, or racing.

The *three-quarter shoe* is either one which does not reach back to either heel by 2 or 3 inches, or one which is deficient of one of the sides or quarters.

The *feather edge shoe* is straight and narrow on one or both of its branches, usually the inner, and is used to prevent "brushing" the fetlock or the inside of the knee of the opposite limb. It is sometimes called a "knocked up" shoe.

The *calkin* and *toe-piece* are projections of iron at the heel or toe to provide a grip in starting heavy loads and in ascending or descending hills. The toe-piece is rarely used in the south, but commonly in the north of England. At times either or both may be deemed necessary, but if practicable their use should be avoided. Horse shoes should be as light as is consistent with the work and wear demanded. The force required to lift and advance every extra and unnecessary pound of iron during a year is enormous.

The *weight of the shoe* is liable to very great variation, depending on the class of horse and the fancy of the owner. The action is often improved by the use of weighted shoes, and large heavy shoes are often used to give appearance of size to the feet, and a thumping sound with the impression of great weight.

From three to four weeks is about the *average duration* of a road-working horse's shoes, though there is a remarkable difference in individuals; some animals require new shoes every fortnight, while others show little wear at the end of five weeks' constant work. The cost of shoeing differs very widely in different parts. Thus in the west of England the nag horse is shod for from 2s. 6d. to 2s. 8d., while in London the charge is from 5s. to 15s., the margin often, it is to be feared, depending on circumstances quite outside the real cost of the shoeing.

Bad or faulty shoeing may be harmful in many directions. The effects of *over long toe* has been touched on. We may add to the list, the chance of "overreaching," that is striking and often severely injuring the heel of the fore foot with the toe of the hind. "Forging" or "clicking" is a sound made

by striking the fore shoe with the hind, and like the foregoing may sometimes be remedied by shortening the hind toes and narrowing the web of the fore shoe.

Capped elbow may result from over long heels of the fore shoe.

Brushing the fetlocks is sometimes attributable to badly fitting shoes, and the same may be said of *corns.*

Lameness, matter in the foot, and *quittor* are common results of "pricks" and "drawn nails." Calkins by injuring the coronets of the opposite foot may destroy the horn secreting structures, and lead to sandcracks, false quarters, etc.

Hoven in Cattle.—*See* Tympanitis.

Hummellers.—Hummellers or awners are chiefly employed to shorten awns of barley after the corn has passed through the threshing machine, or to rub off the "white heads" or chaff adhering to grains of wheat after threshing. There have been great complaints from maltsters that farmers set the beaters of their threshing drum too closely to the concave, and so do not merely break off the awns, but bruise or skin the ends of the grain, consequently spoiling the sample of malt. No doubt much of the injury is done in this way, however it tends to give a plump appearance to the grain, and to suggest the uniform appearance which maltsters look for as indicating in an uninjured sample, uniformity in germination, consequently a sample which can be conveniently profitably malted. Far too much has been done to effect the appearance of uniformity, and where the threshing machine or flail did not cut off the awn close to the kernel, the hummeller has been used. Used with discretion, it is a useful instrument, but it may overwork a sample, therefore it should be judiciously employed. If maltsters would recognise the value of a sample when left rough-ended, that is without all the ends being cut closely off, then there need be little use for the hummeller. On the other hand, farmers should set their concaves and hummellers so as to make a neat sample. Hummellers attached to threshing drums are generally placed in the course of the corn just before it leaves the last blowing, for when it comes out of the hummeller the awns are blown away, and the final sifting is performed.

Hummellers take various forms, but the most usual consists of a concave through which runs a spindle carrying a number of helically placed blades, which, as they rotate, chop through the corn contained in the concave, and knock off the awns still adhering. If the corn is allowed to pass through the hummeller concave rapidly and in a thin stream it is little affected by the hummeller, but if it is held back so as to be constantly full, the grains become subjected to very hard chopping and rubbing, and if very hard or very damp the skin as well as the awn may be torn off. The helical position of the blades carries the corn through and forces it out of the hummeller.

Hummellers should be capable of being sensitively set so that the amount of work done on the grain may be regulated nicely. Moreover, those in charge of the threshing should watch the sample as it comes from the machine, and regulate the hummeller accordingly as conditions require. Corn in a stack almost always varies in moisture in the roof, body, and bottom, and moisture mainly regulates the toughness of the awn, therefore the setting of the hummeller to best suit one portion of the stack is unlikely

to equally suit the others; hence the need for constant attention and regulation. When threshing wheat cut young, or that in a damp condition, especially cone wheat such as "Rivetts," the spikelets will often break off without the grain being knocked out, or individual grains will retain their chaff to the detriment of the sample, and it is desirable to free the kernel, therefore the hummeller can be used with advantage, for with sufficient rubbing the grain is set free. Hummellers are sometimes used independently of the threshing machine, the same principle of the rotary knives within a concave being employed, sometimes with and sometimes without a blower. Hand hummellers have, however, become almost obsolete except where the holding is too small to require the assistance of the threshing machine and where the flail suffices. The most common hand hummellers were a kind of hand tool where a series of blunt blades about a foot long were attached to a cross bar, parallel an inch or two apart with the edges to the ground; to these a long handle was attached, and the workman, having laid out a thin layer of corn, repeatedly chopped through it until the awns were removed. Sometimes the blades were placed on a drum horizontally with the edges outward, and this was wheeled over the grain until it was freed of the awns. These drums were generally about 2 feet in width.

Humus is perhaps best defined as "vegetable mould" (Liebig), and must therefore be of indefinite composition. The term has been used in various senses, as for example for certain products of the decomposition of sugar, starch, and other forms of vegetable matter when acted upon by acids or alkalies. It is described by chemists under various names according to its modifications, such as ulmin, humic acid, and humin. The forms in which it is soluble in alkalies are called humic acid, while those which are insoluble have received the names of humin and coal of humus. Warington defines it as the brown or black organic matter of surface soils, the product of processes of fermentation, or of particular oxidation. When exposed to the air it undergoes further and continuous changes until it disappears in the forms of carbonic acid gas and water. Humus may be prepared in the laboratory from definite sources, and differs materially in composition from humus as found in a fertile soil, although in many respects such artificially produced humus resembles natural humus. Humic acid is capable of forming "salts" with various bases in the soil, and if soil is treated with cold hydrochloric acid and washed, the salts are decomposed and the humic acid is freed. If ammonia is added to the filtrate, humate of ammonia is the result, and the insoluble humin is left (Warington).

The humus of soils always contains nitrogen, although that produced in the laboratory need not do so (if, for example, it is prepared from carbohydrates), and this is a point of great importance in considering its value as a fertilising element. Under the action of bacteria, soil humus yields both ammonia and nitric acid, and the former combining with humic acid forms an amide. Previous to 1840 and the appearance of Liebig's *Chemistry of Agriculture and Physiology,* humus was looked upon as constituting the standard of fertility in soils, and in a measure its importance has been reinstated. Liebig, however, demonstrated certain propositions which shook the "humus theory." He showed that in forests the amount of humus increases notwithstanding the growth of many tons of timber per acre. Also that a heavy crop on arable land leaves the soil

richer in humus than it found it, although the land is in a more exhausted condition as regards future cropping. The crude idea that plants feed on humus has long been exploded, and it was to Liebig that we owe the demonstration that humus is a result of vegetation rather than a cause of it, and that the accumulation of vegetable matter in a soil is due to crop residues in the forms of roots, fallen leaves, and dead plants. He successfully combated the view that humus, as such, is a plant food; and he founded his "mineral theory" on the ruins of the older "humus theory." Liebig no doubt went too far, and it was owing to the experiments of Lawes and Gilbert at Rothamsted that his "mineral theory" of plant nutrition was overturned.

The modern view of the importance of humus is not in any way a return to the old idea of humus as a direct plant food. It is based upon the decomposition of humus into elements of plant food, and, in a special degree, to its being a source of nitrates and ammonia salts of humic acid (amides). It is liable to be forgotten that humus, as it exists in soils, is also a source of *mineral* plant food, as is clearly shown by its leaving an ash when burnt. Vegetable mould necessarily contains the ash ingredients of the plants from which it was derived, and its complete decay must restore those elements for the use of growing crops. Farmyard manure rapidly passes into the form of humus when rotted, as it is evident that both its nitrogenous and mineral constituents must very shortly be reduced, with its carbonaceous mass, into vegetable mould or humus. It is as a source of plant food, in its gaseous or soluble products, that humus must be regarded so far as its manurial qualities are concerned.

It possesses other properties which must be considered before we can form a just estimate of its actual value, and these properties are so important as to require detailed notice. As a source of carbonic acid during its oxidation, it is the means of impregnating the soil water with this gas, and thus increasing its solvent action upon the mineral phosphates and alkalies of the soil. Carbonic acid is a powerful solvent, and a potent means of disintegration. Moist vegetable matter in contact with compact rocky matter assists in its degradation or disintegration before the same substances are further reduced by glacial action or running water. The same changes are continued within a soil, causing the minute fragments of compact mineral matter to yield up soluble plant food under the influence of decaying humus.

The power of vegetable matter in soils to absorb and retain moisture is indirectly a cause of fertility. A soil which is rich in organic matter absorbs moisture from the air. Humus has been found to absorb 8 per cent. of its weight of moisture from the air in twelve hours, and 11 per cent. in forty-eight hours; while sand absorbs none, and dry clay from 4 to 4·8 per cent. Its capability of holding water is illustrated by a cubic foot of saturated humus containing 50 lb. of water, while the same volume of wet sand only holds 27 to 30 lb. and of wet clay 47 lb. The same porosity which enables humus to absorb and retain water confers similar powers upon it as regards fertilisers and odours. It rapidly absorbs ammonia, and hence is an excellent covering for heaps of farmyard manure. It retains fertilising matter, and for this reason is used as an absorbent for liquid manure. These properties of humus are all transferred to the soils in which it occurs, and vary in intensity with the proportions in which it exists. Soils rich in humus are absorbent and retentive to water, gases, and fertilising matter in a high degree, while those in which it is absent are arid and hungry. To fully exhibit the importance of humus, a soil may

be deprived of it by exposing it to a low red heat. It will then be found to be reduced to a harsh mixture of sand, clay, and lime, without cohesion among its particles, and with only a fraction of its original absorbent power. Oxidation proceeds freely in a soil rich in vegetable matter, and is accompanied by such a burning off of carbon as greatly increases the proportion of nitrogen in the resulting humus. Warington has shown that while the proportion of carbon to nitrogen in roots and stubble is 1:43, in moderately rotted farmyard manure it has risen to 1:18. As the carbon disappears, this proportion of nitrogen to carbon increases to 1:13, 1:10, and even 1:6. It is not until a large proportion of the carbon of vegetable matter has been dissipated into the air that the residue can be spoken of as humus; and it is then acted upon by nitrifying and ammonia producing bacteria and becomes a source of nitric acid and ammonia.

Earthworms live on vegetable mould, as shown by Darwin in his last work; and it is in passing through their bodies that it is triturated in their gizzards, and reduced to an impalpable condition, mixed with the finest particles of earth, as illustrated in worm-castings. The richness of old pastures is due to vegetable mould or humus; and earthworms play an important part in accumulating it at the surface. It is to them that the deep covering of humus, characteristic of old pastures, is in a large measure, due. Humus is the basis of all vegetable soils, such as peats, and to a less extent, of garden mould. Soils in which it occurs in overwhelming proportions are often sour on account of the free humic acid they contain. They are met with as black peats, and require drainage, liming, claying, and additions of mineral fertiliser, and then become extremely productive. They are always rich in nitrogen.

The importance of humus is thus seen to be established, but a few qualifying remarks are necessary. In the first place, humus is undoubtedly originally a result rather than a cause of fertility, and this is proved, first, by its being the remains of vegetation, and, secondly, by the well-known fact that lava, which cannot contain any organic matter, is very soon pulverised by cooling and by atmospheric forces, and produces soils of exceptional fertility. Humus is, of all the proximate constituents of soils (we refer to clay, sand, lime, and vegetable matter) the one which is not inherent in fertile land. It is a product of vegetation, which must first have subsisted without it. It is both a measure and a cause of fertility, but is not essential. This is also proved by water culture; for plants will thrive in water, if fed with pure salts of ammonia, nitric acid, and mineral bases. We therefore see that humus is a non-essential, because high fertility can exist without it. It appeared to Liebig as an accidental accompaniment of fertile soils, and he considered that the carbonic acid and combined nitrogen of the atmosphere could be relied upon to supply its elements; and that the science of manuring consisted in supplying earthy matter suitable for plant nutrition. What he failed to grasp was, the importance of "soil-nitrogen," and the paramount importance of humus in supplying it.

Hunters.—The breeding and "making" of hunters has been an important branch of English agricultural economy for centuries. The chase has been, almost from time immemorial, a favourite recreation with Englishmen of all ranks. Kings and nobles and yeomen have taken part in it. There were professional huntsmen in Saxon times as there are now, and though hunting in olden times was a very different thing to the quick

Leicestershire bursts of to-day, yet even in those days the truth of the saying of the sporting bard, "that hunting on foot is but labour in vain," was fully realised. The hunter being as essential to the well-being of the noble and small country gentleman in those days as the war horse, the breeding of hunters consequently took a very prominent place in rural economy from, at any rate, the period of the Norman Conquest.

Yet notwithstanding this very obvious fact, the hunter has never yet been established as a breed, and though there has been much talk of establishing a hunter breed of late years, there does not seem a great prospect of it becoming an accomplished fact. Sir Richard Green Price in his contribution to Sir Humphrey de Trafford's *Horses of the British Empire*, says very pertinently that the hunter is a type rather than a breed.

If we go into detail, it may be said that hunters are of many types classed under one head. The differences of opinion as to what a hunter should be are remarkable, and the curious thing about them is that a man is generally not content with selecting the class of horse which he would ride himself—he also tells his friends what they ought to ride. Especially does the light weight take upon him to tell his heavy friend the class of horse he should ride—quite oblivious of the fact that if the heavy man is really keen about hunting he is generally very well mounted, and in a good place when hounds run.

It is not to be wondered at that there are so many different types of hunters, for there are, in every hunting field, many different types of sportsmen—and some whom it would be difficult to class as sportsmen at all. There is the hard rider, who only wants the horse he rides to gallop and jump and stay, who cares nothing about manners, and whose friends say admiringly that he can "ride anything with a head on." Then, a much larger class, are the men who want to see what hounds are doing—who want to ride to hounds and who do ride to hounds—but who insist upon good manners as well as pace, stamina, and flippant jumping. These are the men who give good prices for their horses, and so do those who, having lost their nerve, content themselves with riding the lanes, or a line of gates and crossing a few easy fences, relying on their knowledge of country and "the way of the world in the woods," for seeing a good deal of the sport, and seldom relying in vain. Then there are those who ride to the fixture coffee-house with their friends, and manage to get home to a late luncheon, their only object being exercise.

It is obvious that these different classes of riders require very different types of horses. Those who ride quietly along on the line of the chase are not likely to be found on the same class of horse as those who cut out the work and try to be as near hounds as circumstances will admit, however big may be the country. Nor is the heavy man, who likes to see as much sport as he can, and whose weight makes it almost impossible for him to ride to hounds, likely to be found on the same type of horse that a hard-riding 15-stone man sends over a country with the same nerve and resolution as his lighter brother-sportsman. And so it is that different men have different types of horses in their eye when they talk of hunters, and that we see all sorts and sizes when there is a class of local hunters, and the judges find that to pick the prize-takers "all of a sort" is an impossibility.

The horse, however, which may fairly be described as the hunter which the breeder desires to produce is the fashionable well-bred hunter, capable of carrying a man in front when hounds run fast over a big country, and

Parsons.

Typical Hunter Sire.

Parsons.

Hunter Brood Mare and Foal.

capable of carrying from 11 to 15 stone or upwards. This is the horse which has the most commercial value; it is a horse of this description that an old sportsman loves to talk of long after his hunting days are done; it is the horse the breeder endeavours to produce. It is a well-known saying of Major Whyte Melville, than whom none knew more about hunters, that the best of all hunters is a thoroughbred with brains. No one will be inclined to dispute that fact, but thoroughbred hunters—especially thoroughbred hunters up to weight—are few and far between. Nor is the reason far to seek. During the last sixty years the value of the thoroughbred horse has been rising by leaps and bounds. It is unnecessary to enter into the reason of this increase of value here; it is sufficient that it is a well-known fact. So economically such studs as those which Sir Charles Strickland and Sir George Cholmley owned in Yorkshire are no longer possible.

This increase in the value of thoroughbred horses has also had another effect. It has naturally increased the service fees of stallions. Not so very many years ago such a service fee as 200 guineas was unknown, and only one or two horses were standing at more than 50 guineas. The latter is now quite a small fee by comparison. This, of course, again adds to the cost of breeding thoroughbred hunters. Nor can a man be blamed for taking a good price for his yearling when he has the chance, for the profit is a ready one and he avoids risk. But even if thoroughbred hunters were more easily come-at-able than they are, it is scarcely likely that they would suit everyone. The thoroughbred horse is much more irritable and more easily put out than his more plebeian-bred brother, and, as a rule, he will not suffer his mouth to be interfered with, especially at his fences, without resenting it. Unfortunately, the British horseman, as a rule, is not endowed with the lightest of hands, and when irritable, light-mouthed horses and men with hands which are—well, not light, get together, the result is not comfortable to either of the partners, and if the horseman be at all nervous, he will have a very unpleasant time indeed, whilst if he is not he will get more than his share of falls—and probably blame the horse.

No unprejudiced man would think of saying that a thoroughbred is the best hunter for the average hunting man, but no man who has ever got into the way of riding thoroughbreds, of humouring their caprices, which are many, and of taking no notice of their sudden fits of jumping about and shying at something a couple of miles off, will ever ride anything else if he can get one. And if a man is a good judge and will be patient and painstaking, he can get thoroughbred horses to carry him yet. But he must buy them when they are yearlings and look after their growth and development himself. Many a strong useful yearling is knocked down at the yearling sales for 25 guineas or under, and if the purchaser takes pains to buy a yearling with good limbs and great knees and hocks and good shoulders, and does him well, he will be surprised at the result when he is six years old, if it is his first attempt in this direction. Any yearling is well enough bred to make a hunter, though the King Tom and Flying Dutchman blood, if it can be got for the money, and sometimes it can, is to be preferred. All of that blood are fine jumpers, but those of the Flying Dutchman strain are apt to be rather hot-tempered. The ambitious man, who wants to ride thoroughbred horses on the cheap, must never give more than 25 guineas for a yearling, for some of them will go wrong in spite of the most careful treatment and handling. But if one in four turns out a first-rate hunter he will have no reason to find fault, for the others will generally keep their cost together if they live. The writer could tell of a much better average than that, but in dealing with hunter stock it is as well not to be too

sanguine. It must always be borne in mind that if the profits are big so are the risks, and the better and more valuable the horses, the greater the risks.

The history of hunter breeding is a curious one, and, so far as one is able to trace it, it seems to have run in cycles. One theory was followed by another in a succeeding generation, and this again was supplanted by a variation of the original theory; and then the original theory itself came into fashion again. Such seems to have been the history of hunter breeding since the days of Queen Elizabeth.

Blundeville, who is the first English writer at any length on horse breeding, advises that the mares should be of "an high stature, stronglie made, large and faire, as the mares of Flanders and some of our own mares be," and says that the stallion best adapted for siring hunters is the "Horse of Barbarie," *i.e.* the horse of Eastern blood. Then not very many years later Gervase Markham advises the "Bastard Courser begot of the English," which we may take it is the first mention we have in history of the half-bred hunter sire that has been so much written and talked about during the last thirty years. Markham, however, would seem to contradict himself, for a little earlier in the same book he says, speaking of hunters, that "the English Horse bastardised with any of the former Races first spoke of is the best." The former races include "the Courser of Naples, the Almain, the Sardinian, or the French," which were all practically descended from Eastern blood. Richard Blome, whose *Gentleman's Recreation* was published in 1688, says, "If you would breed for hunting, make use of a Turk or Barb, or a well-bred English Horse that has given proof of his goodness and speed," *i.e.* of what we would call in these days a thorough-bred.

J. Fairfax, writing a hundred years after Blome, says, "Procure either an Arabian, a Spanish, or a Turkish horse, or a Barb for a stallion, which is well shaped and of a good colour to beautify your race"; and after having described these various breeds and where they were to be obtained, he goes on to say, "The next thing to be considered is the choice of mares, and, according to the Duke of Newcastle's opinion, the fittest mare to breed out of, is one that has been bred of an English mare by sire and dam, that is well forehanded, well underlaid, and strong put together in general; and in particular, see that she have a lean head, wide nostrils, an open chaul, and the windpipe straight and loose; and of about five or six years old."

Then some eighty years later has come to the front once more—in theory, for we do not see much of him in the concrete—the half-bred hunter sire, the bastardised English courser of Gervase Markham.

It is interesting to compare the descriptions of hunters in the old writers with the descriptions of them in the nineteenth century and with the hunter himself as we see him every day. It seems needless to say that writers of all ages insist upon speed and stamina.

Blundeville's description is too long to quote in full, but some of the most salient points may be referred to. "Your horse should have a blacke, smooth, dry, large, and hollowe hoofe; the crownes above his hoofes should be small and hairy; his pasterns short, and that neither too lowe, nor yet too high, so shall he be strong underneath and not apt to founder. His jointes great, his legs straight and broad, his shoulders long, large, and full of flesh. His necke rather long than short, great towards the breast, bending in the midst and slender towards the head. His ears small, or rather sharp, and standing right up, being of a just length and largenesse, according to the stature of the horse. His forehead leane and large. His

jawes slender and leane. His nostrils so open and puffed up, as you may see the read [red] within, apt to receive aire. His mouth great. And finally, his whole head together like a sheepe's head.[1] His withers or walleis would not onlie be sharpe pointed, but also right and straight, so as a man maie plainlie see from thense the departure of his shoulders. His back would be short, and that neither rising nor falling, but even and plaine, so shall it be strong; which you shall soon trie if you ride him."

A hundred years later, Blome advised his readers neither to hunt with what he called the deep-mouthed hound, which he said was "too lazy an exercise for one that would keep himself in vigour"; nor with the very fleet ones as some of the northern, "because to follow those extraordinary fleet ones, a man must have such light horses and keep them so finely and nicely that they are not fit for any other service." Blome, like all the old writers, looks upon the hunter as a horse that is likely ultimately to find work on the battlefield, and so insists upon a much heavier horse than was necessary for hunting alone. And, curiously enough, after he has used the words quoted he says that our "twelve stone horses," by which he meant horses that ran for plates—thoroughbred horses as they would be termed now, if properly managed, made admirable hunters.

"Nimrod" is very diffuse, his description of the hunter spreading over several pages, and it will be necessary to curtail it considerably. For "Nimrod," like Blundeville, not only gives a description of the hunter but goes minutely into the reason why such details of conformation are necessary or desirable. Says he: "In a hunter the proper position of the head is of the greatest moment, as without it the rider cannot handle him properly at his fences. Although length of neck in a hunter is not desirable, length of shoulder is indispensable. Horses have raced well with short upright shoulders; but it is impossible that one so formed, however good he may be in his nature, or even in his general action, can be a safe hunter, and for this reason a hunter is constantly subject, by down-hill leaps, leaping into soft ground and getting his forelegs into grips or unsound ground, to have the centre of gravity thrown forward beyond the base of his legs; and it is more or less recoverable according to the length of his shoulder. By length of shoulder is meant obliquity of the scapula or shoulder bone, by which the point of the shoulder is projected forward. The setting on of the arm, which should be strong, muscular, and long, is of much importance to a hunter. The width and breadth of the knee, when considerable, are great recommendations to hunters, as admitting space for attachment of muscles. The cannon bone can scarcely be too short in a horse that has to carry a heavy weight; round legs are almost sure to fail; those of the hunter should be flat, with the back sinews strong, detached, and well braced. The foot of the hunter must be wide. He must be deep in his chest or brisket, that is, from the top of the withers to the elbow. Numerous are the narrow but deep horses, in their 'girth,' as the term is, that have carried heavy weights in the first style, with hounds; but no matter how wide a horse may be, if he have not depth, he cannot carry weight." Speaking of weight carriers and the scarcity of good 16-stone horses, he goes on to say, "The stamp of animal most approved of for this purpose is the short-legged, thick, but well-bred horse, not exceeding sixteen hands in height, but appearing, to the eye, half a hand below that standard." Than which it would be difficult to find a better definition of a weight carrier.

Here and there, there are hunter studs. Some country gentlemen, of

[1] This seems a curious comparison.

whom Lord Middleton may be named as one, breed very extensively themselves as well as keep good stallions for the use of their friends and neighbours. But few farmers go largely into the breeding of hunters. If a man's farming is subsidiary to his business as a horse-dealer he may breed a few, but he does not enter on the breeding of hunters on any large scale, for the sufficiently obvious reason that there is too long to wait for the turn-over. And though a man with a large holding may sometimes be found with a stud of hunter brood mares, farmers seldom keep more than two or three.

Some years ago farmers in many districts bred more hunters than they do now, the reason for this being found in the very different class of draught horse which prevailed in many places before the Shire Horse Society was established, and the demand for very heavy horses became so good and so steady. The cart horse of many districts was clean legged, active, and not outsized—the mares inclined to be rather under than over 16 hands, and the breed was distinguished for its good shoulders. Many of the weight carriers that were bred in the East Riding of Yorkshire were bred from these native carting mares. Then, again, farther north the Cleveland Bay and the Yorkshire coach horse made a capital foundation, if they were mated with the right class of thoroughbred.

It is difficult to say how these native cart mares were really bred, but as there is no doubt that there have been several considerable admixtures of thoroughbred blood from time to time in other native draught breeds, it is by no means improbable that there was at any rate a spice of the thoroughbred about them some generations back. It is a matter of general knowledge that in the eighteenth century many excellent thoroughbred horses were scattered about amongst farm houses and villages, and left good stock behind them of which they never got the credit, and what happened to the Cleveland Bay breed with Traveller may well have happened to the East Riding cart horse with some of Traveller's contemporaries. The East Riding cart horse practically disappeared some eighteen years ago. He had been on the downward course for some time; his days as a cart horse were done—there was no longer any need for him. But in his day he worked the heavy clays of Holderness as well as his successor, and he bred a hunter now and again whose sale helped materially to make up the half-year's rent. The hunter and remount problems would have been easier of solution had he not been absorbed in the Shire. Cleveland Bay and Coaching mares are still available, and here and there perhaps there may still be found a few light carting mares with good shoulders such as might breed a hunter. Whenever this is the case, hunter breeding may well be carried on to advantage. The mare will fill her place in the economy of the farm, working every day, save for four or five weeks about the time of foaling; though, of course, her work would not have to be very heavy during the latter weeks of her pregnancy, and she should be kept out of the shafts.

Mares of this description should not be mated to a big loosely made sire. Too may breeders are impressed with the notion of big bone, and do not take sufficient notice of the quality of it. Nor does it necessarily follow that a big stallion will sire strong stock. Size is not power—action is. Therefore a thoroughbred sire to get hunters should be level and compact, and not too tall; 15 hands 2 inches is a very good height, and if the make, shape, and action are correct, a horse would not be any worse if he were under that height. In the writer's opinion he would be better under than over the height. Perion, one of the most successful of hunter

sires, was well under 14 hands 2 inches. Homœpathist, another very good sire, was also about 14 hands 2 inches, and both of them were sires of big powerful hunters.

In a thoroughbred hunter sire quality and courage are indispensable. The head should be well carried, the neck of medium length, and the head and crest should be specially masculine in character. The cannon bone should be short, the arms big and muscular, and the shoulders should be long, well placed, and powerful. Shoulders have more to do with carrying weight than many people are aware of or would believe, and they are a very important point in a stallion. The quarters should be long and muscular, and the loins powerful, and a matter of great importance is how the horse stands on his hind legs. A horse that leaves his hind legs behind him—that does not flex his hocks properly—should be avoided, his stock as a rule will be weak. Action and balance are also of the greatest importance. A horse that is evenly proportioned and has true action is always moving without undue effort; he will stay longer, carry more weight, and last longer than the horse that is badly balanced and has not perfectly correct action.

The question at once occurs to the mind, why should not mares that have been fine hunters themselves also breed fine hunters? There seems to be every reason why they should, but they occasionally are disappointing. For this the uncertain breeding of many of them is accountable. The saying that like gets like, or that like breeds like, which we so frequently hear brought into an argument as if it were irrefutable, is only true to a limited extent. Many a hunter-bred mare that has been a good performer herself breeds very moderate weedy foals. Her dam has been a very cross-bred mare perhaps—a regular mongrel, and she has bred back to a remote ancestor, which is as likely as breeding altogether to the sire. A big fine mare herself, when she is put to the stud she breeds weeds.

It has been said with a good deal of truth that in taking a hunting mare to breed from, care should be taken that she has at least two crosses of thoroughbred. It does indeed seem reasonable to think that it will be safer to breed from a mare whose dam and grandam have both bred good foals, than from a mare who, however good looking she may be, or however good performer she may have been, is what is known as a "chance bred one." In the case of a mare whose dam has been of the Cleveland Bay, Yorkshire coaching, or light cart-horse breed, the same remark does not apply so strongly, as there are not so many mixed ancestors to breed back to. It is, however, quite possible that the hunter brood mare once crossed from any of these breeds will throw foals showing less quality than herself, and that her daughter may throw foals of exceptionally fine quality. There are plenty of instances of what I mean which will at once occur to the memory of those who follow up the hunter classes at the principal shows. Perhaps it will be as well to give one from the records of the past. Lady Bennett, a well-known prize-taker in the fifties and sixties, was by St. Bennett, dam by Lord Collingwood, grandam a Cleveland mare. She was a brilliant hunter, and a famous brood mare. Her son, Joe Bennett, by Hark Forward, won in the best of company all over the country, and she bred other good horses, though nothing equal to him. I do not remember that she had a filly, and she had not many foals, as she was a fair age when she was put to the stud.

The formation of breed societies, and the attention which was directed to the whole question of horse breeding, and especially of light horse breeding, led to the formation of the Hunters' Improvement Society in 1884, and to

the establishment of the Royal Commission on Horse Breeding and the Queen's Premiums in 1888.

The Hunters' Improvement Society, beginning in a small way, soon grew to be a strong Society, quite capable of standing alone, and having a show of its own. The first idea was to encourage owners of stallions to let their horses stand at reasonable fees, and the classes at their initial show in 1885 were for stallions only. There were two classes, and it must be admitted that the success of both was very great. There were twelve entries in the class for horses that had not up to that time been at the stud, the prizes going to Lord Tredegar's Chevronel and Mr. Clark's Jack Tar, with Sir J. D. Astley's Rowell reserve, who had some very useful horses behind them. In the class for older horses there were twenty-three entries, with the prizes going to Sir Walter Gilbey's Pedometer, a valuable sire because of his King Tom blood, Mr. Oldham's Knight of the Launde, the Stand Stud Company's Troll, and Mr. Blenkiron's Charles the First, and other good horses were shown in Pepperment, Fabius, and Scot Guard, the latter of whom, however, failed to pass the veterinary examination on some minor point.

In the following year the Hunters' Improvement Society increased their programme by adding a class for mares, and the show rapidly began to increase in importance, During the early years of its existence the Society held its annual spring show in London in connection with the Hackney Horse Society, but in the year 1894 it was able to hold a show alone. Since that date the Society has made vast strides, and it is not too much to say that it has had a very important influence on hunter breeding. At its annual shows large classes of very good horses are shown, and it may fairly be said that a steady improvement has been seen from year to year.

An energetic and enthusiastic party in the Society have been, from its commencement, endeavouring to make of hunters a breed instead of a type, and there has been much correspondence and argument on the subject. A controversial matter of this kind can only be treated here from the historical standpoint.

After considerable discussion, the Council of the Society adopted the principle, and in 1903 their biennial publication, which had hitherto been known as the Hunters' Improvement Society's Prize Record of Hunter Mares and Thoroughbred Stallions, appeared as the Hunter Stud Book.

It can scarcely be said that great progress has been made in forming a hunter breed. Several of the hunter sires which have been registered are thoroughbred, and though some half-bred sires have been very successful, it would appear that the day when the hunter will become an established "breed" on the same lines as the hackney or the thoroughbred, is still far distant.

As an instance of how the Hunters' Improvement Society has progressed, it may be pointed out that there were 461 members in 1886, and that there are now (1908) 1735 members, 103 Associated Societies, and 11 regiments subscribing. The first volume was made up of 94 pages; the last, which has just been published, contains 393 pages.

The stock from registered dams which were entered and won prizes in 1906 and 1907 show how breeders appreciate and support the work of the Society. In 1906 in the classes for breeding and young stock there were 110 entries, of which 75 were from registered dams. Of these, 12 took first prizes, 17 took equal premiums, and 4 were reserve and 2 highly commended. In 1907, out of 123 entries, 85 were from registered dams, of

which 9 took first prizes, 17 took equal premiums, 6 were reserve, 9 were highly commended, and 10 were commended.

There was much talk in the later "eighties" of the scarcity of good thoroughbred stallions at a service fee which was within the reach of the tenant-farmer or small breeder, and in 1887 the money which had for many years been devoted to Queen's Plates was diverted to premiums for thoroughbred stallions which were to stand in certain districts at a reasonable fee, and this, together with the conditions, were specified by the Royal Commission on Horse Breeding which was then formed.

It was at the suggestion of the late Queen Victoria that this new departure was made. At first twenty-two premiums of £200 each were given by the Royal Commission, the Royal Agricultural Society giving three more of the same value for the district in which the annual show was held. In a few years' time the Royal Agricultural Society discontinued their premiums and the scheme was altered to one of twenty-eight premiums of £150 each, and so it stands at present. That this is all too small a number of horses for the country is recognised on every hand, and many schemes have been suggested to improve the position. There seems only one way of doing this, and that is increasing the number of premiums without decreasing the amount of them. Any decrease in the amount of the premiums would inevitably lead to a worse class of horses being shown.

The critics of the Royal Commission have not been very sparing of their censure. They say that horses have won premiums that were not worth the premiums they won. That may be the case in individual instances without affecting the scheme as a whole. There can be little doubt that since the King's premiums were given, a better class of stallions has gradually been at the disposal of breeders of half-bred stock. There may have been—indeed, there always is, this danger at a horse show—occasions when the premiums have been given to the class of horse we want to breed instead of to the class of horse necessary to produce them. This was pointed out to the writer when the Royal Agricultural Society gave five premiums to stallions in 1887 at the Newcastle Show, by that good judge and great authority on horse breeding, the late Mr. A. L. Maynard. But no system is altogether perfect, and opinions vary widely as to the best horse for siring hunters.

There is one circumstance connected with hunter breeding yet to be touched upon, and it will only be touched upon lightly. That is, that unless a man is a horseman, and can ride and make his horses, a good deal of the profit goes to the dealer and not to the breeder. There is something in the contention, but not so much as appears on the face of it. A dealer's connection costs him a great deal to form and to keep together; a certain proportion of his horses are sure to go wrong; and he has sometimes to give long credit, and sometimes he makes bad debts. So that there is a considerable drain upon the big prices he makes. And, again, the big dealer is always ready to give big prices for good horses. The modern trade makes a dealer chary of buying at an earlier age than five unless the horse be something very much out of the common, but a very good four-year-old that can win prizes in good company is quickly snapped up.

If a man has no time or inclination to break his young hunters and keep them till five years old, he will not find any difficulty in disposing of good three-year-olds, but they must be good ones. The shows, of which there are so many in these days, afford a capital market.

The subject of hunter breeding cannot be much better summed up than in the words of "Nimrod": "Under the most favourable circumstances, and

with the aid of good judgment, we cannot consider 'hunter' breeding to be a certain source of gain; yet there are many inducements to try it as one branch of rural economics. The money goes out a little at a time, or by degrees, and therefore it is suitable to such occupiers of land as cannot embark in more extensive speculations, and it returns in a lump, oftentimes at a most welcome moment, and in many instances of sufficient amount to render the average of former less profitable years sufficient to cover expenses, if not to leave a profit. There is likewise another inducement to breeding horses (hunters); we mean the pleasurable excitement inseparable from all human speculations, from which more than an ordinary return may be looked for, which is the case here; added to the nearly universal interest attached to the breeding and rearing of every species of domestic animals."

This is putting the case very fairly, and there certainly seems every reason for a farmer to try to breed a hunter or two.

Authorities.—Blundeville, *Four Chiefest Offices of Horsemanship*; Gervase Markham, *Of the Ordering of Horses and Cattell*; Blome, *The Gentleman's Recreation*; the Duke of Newcastle, *A New Way of Dressing Horses*; J. Fairfax, *The Complete Sportsman*; Nimrod, *On Horses and Hounds*; Sir Humphrey de Trafford, *The Horses of the British Empire*; *Hunters*, by Sir R. Green Price.

Hurdles.—Hurdles are used to huddle together or confine sheep, cattle, or other animals for short periods. They are short sections of temporary fences conveniently portable, sometimes placed on wheels, but more often not. Heavy iron hurdles with tubular bars, or with flat bars, standing 4 feet or more above ground, are required for cattle fencing; 4 feet 8 inches is generally regarded as safe bullock fencing; for sheep from 3 feet to 3 feet 6 inches is a suitable height. Iron hurdles are durable, but expensive to purchase and inconvenient to move, and are not well suited in cases where frequent moving is required. Those on wheels are easily drawn into place and set up; those with sharpened feet, two at either end, are difficult to put down on heavy land; and those where they are held in place by lean-to supports, the hurdles themselves placed on an incline, are not well suited to retain flocks of sheep on both sides. A very ingenious hurdle, and one possessing merit over all metal hurdles, is made by Mr. George Coombe, a farmer at Charlton, near Taunton. It takes the form of a one-wheel double hurdle, two lengths, 14 feet each, being hinged at one end, and at the hinge is a wheel. The hinging allows the hurdle to be closed, so that the shepherd can move it about as readily as though it were a light wheel-barrow, or it can be opened out at any angle; two at right angles form a square pen in which sheep may be folded, and nothing more convenient could be devised for retaining sheep for dressing them for foot-rot, the "fly," or other purposes. When setting a long row of these hurdles there is no need to use stakes or other means of support; by setting them on a slight zigzag a base is formed which prevents them from being pushed down; this is made possible because the hurdles are connected by hooks and eyes. Lightness is obtained, because with the exception of one central tube, and the two ends, it is practically a wire hurdle.

Wooden hurdles are more extensively used for temporary folding than are iron hurdles, but there has been a considerable increase in wire or string netting for sheep-folding. Wooden hurdles take two forms—the slat or flake hurdle, and the wattle. The slat hurdle is somewhat gate-shaped, and the wattle, as its name indicates, is made of wattle wood, as in

basket-making. It may be mentioned that in Kent and Sussex a flaked hurdle is called a wattle, and a wattle hurdle a hurdle, a peculiar inversion of names. The slat hurdle is made from 6 feet to 8 feet in length, and consists of five or six slats mortised into heads at either end, being diagonally braced from the top to the heel of the head, and by an upright at the centre. The parts of a 7-feet hurdle are as follows:—Slat 7 feet, head 4 feet, braces 5 feet, central upright 3 feet 6 inches; the thickness of the slat at the end is cut to fit a mortise $\frac{5}{8}$ of an inch. In some districts an iron shackle is placed round the head between the fourth and fifth slat to couple together the heads of the hurdles when the stake is slipped through it, the stake then being driven in by a beetle or mallet. Where the heads of the hurdles are left long so that they may be driven deeply into the ground, it is more customary to tie the heads of the hurdle to the stake by a loop of string or willow. Hurdles used for folding which have to be moved or flitted daily, or at any rate frequently, should not be too heavy for the shepherd to carry five on his shoulder at a time. In some districts hurdles are made of very stout slats of ash, chestnut, or oak, all the joints being held by stout nuts or bolts, rendering them expensive but very durable; however, they are not well suited for frequent flitting by reason of their weight.

The wattle is a good sheltering hurdle, breaking the wind, and on one side or the other affording shelter from the sun. They are chiefly met with in hazel districts, where other wood is scarce. All the hazel wands are split so as to make them work more conveniently; moreover, they do not break so readily when twisted round the uprights. They are specially valuable for use in lambing yards, and for field shelters when the lambs are turned out.

Hybridisation of Plants.—The term *hybridisation* has long been held to apply to the mating of two distinct species, in contra-distinction to *crossing*, when varieties of one and the same species are in question. There are no good grounds for retaining this distinction, for the simple reason that it is impossible to draw hard-and-fast lines between species and varieties. The experimenter finds that it is often as easy to effect hybrid union between certain so-called species, as between varieties of one species. The terms hybridisation and crossing may therefore be held to be synonymous.

At one period it was a prevalent belief that if the progeny of a cross proved fertile, the circumstance was sufficient to show that the parents were of the same species, while, on the contrary, if they proved sterile, the parents were regarded as being of different species. This test of specific identity has been long since abandoned. Its untenableness is rendered more apparent when we note that a good many crosses have been effected between representatives of different genera, as, for instance, between wheat and rye. What constitutes specific, and what generic, distinction is therefore only a question of degree.

In illustration of what may be termed the capricious behaviour of species in regard to their capabilities of entering into hybrid union with each other, examples of garden plants may be cited. The black currant and the gooseberry are both species of the same genus, *Ribes*. They are undoubtedly very distinct in leaf, flower, and fruit. It was long thought impossible to cross them, but their union has been effected by more than one hybridist during recent years. The plants flower profusely, and sometimes bear fruit; the fruit, however, never contains any properly

developed seed. The flowering currant and the gooseberry are similarly related. A cross between them was raised and has been cultivated for many years. Although in perfect health, it has never borne a single flower. Such experiments in crossing show unmistakably that what is termed a genus is a group of species, sub-species, and varieties, with a common ancestor, and embodying inherited characters of a most complex and elusive nature. The history of most species is no doubt immeasurably long. It is generally accepted that they have come to be what they are by reason of their effort to conform to the conditions in which they live, those conditions being expressed and summed up in the comprehensive word environment. It is necessary to guard against reading teleology into their life-history, but we cannot but believe that the living protoplasm of the plant

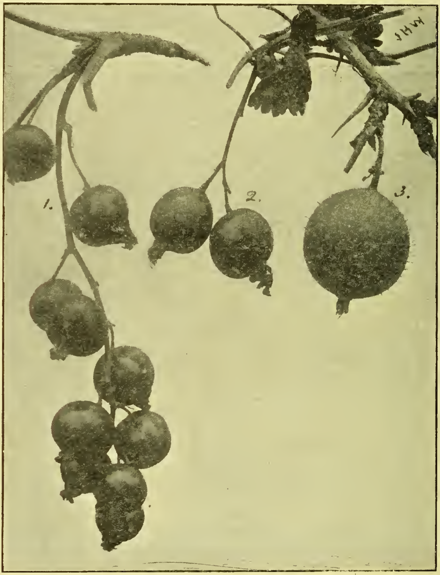


Fig. 1.—Fruits of Black Currant (1), Gooseberry (3), and Hybrid (2).

responds, although not in a sentient way, to changes of environment, and adapts itself if possible to them. Variability in the ordinary acceptation of the term is explained, at least in a measure, by considerations such as we have suggested, and it is a matter which the hybridist must constantly take into account. It is of the utmost importance for him to know whether or not the plants he wishes to employ as parents are what is termed fixed. Fixation implies that the plant has become so constituted that it transmits to its offspring certain characters identical with its own. By some process in the mysterious alchemy of nature it has come to produce egg-cells or fertilising-cells, or both, which, microscopic though they be, are imbued with the power of transmitting forms which do not deviate from the parental ones. The retention of this power is known to be intimately associated with the

continuance of uniform conditions of environment, acting through long periods of time, as, for instance, when plants are left to grow in an undisturbed way in nature. It is generally admitted that plants which, in nature, have not been known to vary to any perceptible extent do, before long, when brought into cultivation, produce progeny which show variation from the parental type.

A theory has been propounded by De Vries, based on the well-known fact that there occur in plants variations which are quite spontaneous in origin and stable in character. For a long period the most conspicuous of them have been known as "sports"; all of them, whether large or small, De Vries prefers to term *mutations*. He has shown that mutation is a very common phenomenon, and he insists that it has far more to do with the evolution of new forms, varieties, and even species, than has hitherto been believed. He points out, further, that the appearance of new forms due to mutation must not be confounded with those arising from hybridisation.

Historical Notes.—The fertilisation (caprification) of the fig was known to the ancients, and they were also aware of the efficacy of dusting the powder (pollen) of the so-called "male" flowers over the "female" ones of the date-palm. It was not until the end of the seventeenth century that attention began to be focused on the reproductive organs of flowering plants, when Grew, the English plant anatomist, showed that the anthers furnished the fertilising material. Before the end of that century, Camerarius, a German investigator, by means of reliable experimentation, demonstrated the presence of sex organs in plants. He recognised the existence of unisexual as well as bisexual (hermaphrodite) flowers, but, unfortunately, he was led to think that the latter always fertilised themselves. He noted the analogies existing between plants and animals in respect of their modes of reproduction, and suggested the possibility of hybridisation being accomplished in plants.

The first hybrid plant of which we have distinct record was produced by an English gardener, Thomas Fairchild, in 1719. It was known as Fairchild's sweet-william, and it was the result of a cross between the carnation and the sweet-william. A broad and firm basis was given to the study of plant hybridisation by Kölreuter, who published his observations in 1761. By crossing tobaccos and other plants he demonstrated many of the fundamental features of hybrids. He showed also the impossibility of self-fertilisation happening in certain flowers, and he recognised the great services rendered by insects as agents in pollination. He was followed thirty years later by Sprengel, another investigator of the highest rank, who made the relationship of insects to plants a special study, and came to realise clearly the importance of cross-fertilisation. Before the end of the century, Knight crossed fruits and peas with the object of securing better varieties. Herbert entered the ranks of plant hybridists at the beginning of the nineteenth century, and he assisted materially in advancing the doctrine that an occasional cross is of value in infusing renewed vigour into the race.

Many botanists entered the field, but it was left to Darwin to bring their labours into line. His great work on *Animals and Plants under Domestication* is a rich store of knowledge culled from the researches of others and incorporated with the records of his own. The labours of Darwin led to increased activity in all fields of biological research, and the science of hybridisation received a great impetus. In spite, however, of the accumulation of an immense amount of information, the chief problems received

comparatively little further illumination. No satisfactory explanation of the vagaries of variation exhibited by hybrids had yet been given.

Mendelism.—Gregor Johann Mendel, an Austrian priest and teacher of natural science, who ultimately became Abbot of Brünn, published in 1865, in the *Transactions* of an Austrian scientific Society, the results of ten years' investigations, under the title *Versuche über Pflanzen-Hybriden.* This communication was lost to sight until 1900, when it was discovered by continental hybridists. Mr. W. Bateson, F.R.S., of Cambridge, had the honour of translating it into English (see *Journal Royal Hort. Soc.*, vol. xxvi., 1901). It would seem certain that Mendel's work, as has happened oftener than once with advanced research, was before its time. Although the periodical in which it was published was somewhat obscure, the paper is quoted in Focke's *Pflanzen-Mischlinge*, a well-known treatise on hybrids, published in 1881. The discovery of Mendel's researches has led to a very great alteration in our point of view of the science of hybridisation.

Mendel fortunately chose peas as the subject of his experiments. They are plants that are easily grown, easily crossed, self-fertilising, and susceptible of being kept true to type. At the outset he grew certain varieties for a time until he was satisfied in regard to the fixity of the features he wished to trace in their progeny. The features in question are distinctly differentiated in pairs, the haulm being long in the one parent and short in the other, the seeds round in the one and wrinkled in the other, or yellow in the one and green in the other, and so on.

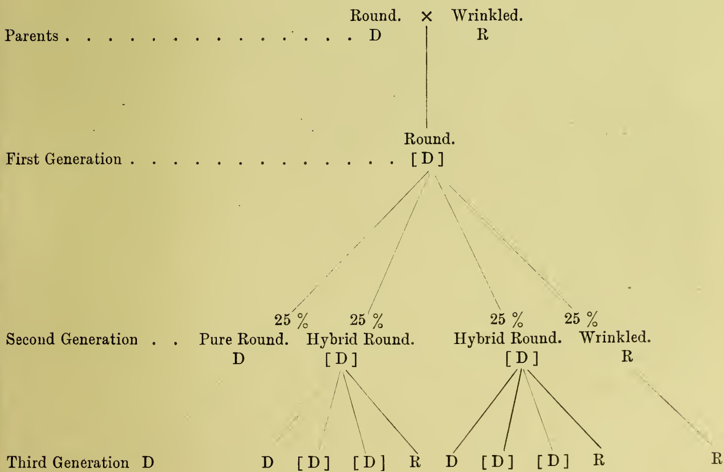
It should be clearly kept in mind that peas are habitually and completely self-fertilising: that is to say, pollen from the anthers surrounding the stigma of a flower suffices to fertilise that flower thoroughly. Insects do not take any part in the fertilisation of peas. One sees bees occasionally making desperate efforts to open the flowers, but it is quite certain that they do not succeed. There is thus no occasion to fear cross-fertilisation when different varieties are growing quite close together; and it will be seen that peas do not fall under the same category as most of the plants which have formed the subject of investigation into the principles of hybridisation, and, further, that they are obvious exceptions to the general rules regarding the advantages of cross-fertilisation. It is very hard to say why peas, with their fairly gaudy flowers, should, in respect of their fertilisation, be so different from other members of the same family, *e.g.*, the scarlet runner or the broom, both being plants in which the floral mechanism is clearly connected with insect visits.

It is not necessary to enter into details of Mendel's experiments. It will suffice to give an account, in as simple terms as possible, of the chief results of his work. To this end it will only be necessary to choose one pair of characters and follow their fate. Mendel crossed a variety of peas having wrinkled seeds with another having round seeds. The seeds resulting from the cross were all round, irrespective of whether the round-seeded parents were used to supply the pollen or produce the seed. It should be mentioned that in peas the effect of a cross can be seen when the seed ripens in the pod, which (as a pistil) had received the pollen of the other parent. The plants grown from the hybrid round seeds bore both round and wrinkled seeds, both forms being frequently found in the same pod. No seeds of an intermediate type occurred. This differentiation of form showed that although the seeds were all round in the first generation, the character associated with the wrinkling of the cotyledons of the plantlet, causing the wrinkled shape of the seed as a whole, had merely been latent and ready to reappear, unaltered, in the second generation. By counting

the round and wrinkled seeds, it was found that the round were almost exactly three times as many as the wrinkled ones, the larger the number to reckon from, the nearer being the approach to correctness in the ratio. The wrinkled seeds when grown transmitted the wrinkling pure to their progeny, not one round seed appearing amongst them. The round seeds, on the other hand, produced plants some of which bore both round and wrinkled seeds in quite the same way that their parents had done, while others were proved to have bred true to the round type. When the two kinds of plants (those with the round seeds only and those with both wrinkled and round seeds) were counted, it was seen that the round seeds from which they had been grown must, although they were outwardly alike, have been so constituted that two-thirds of them were really hybrid in character while one-third was pure, the purity being indicated by the entire absence of wrinkled seed in their progeny.

To the round form Mendel applied the term *dominant*; the wrinkled form he named *recessive*. Harking back to the second generation,—that in which the proportion of round to wrinkled peas was found to be 3 : 1,—he was able to show that the segregation was really such that one-fourth of that generation consisted of pure dominants, one-half hybrid dominants, and the remaining one-fourth recessives, the formula now becoming 1 D : 2 DR : 1 R.

Substituting [D] for DR, the genealogical tree may be put in its simplest form thus:



It is a familiar experience on the part of seedsmen to find a few wrinkled peas appearing in a consignment of a round variety. The presence of these wrinkled peas is explained by assuming that sufficient care had not been taken by the raiser to eliminate impure or hybrid dominants from the strain.

But seeds carry more characters than one. If one of the seeds is yellow as well as round, and the other green as well as wrinkled, it is necessary to

note each character separately. Mendel found that the yellow colour stood to the green in identically the same relation that the round stood to the wrinkled character, the yellow being dominant and the green recessive. If for the moment no heed is taken of the shape, and the seeds are counted with respect to the colour, the same formulæ are reached as are given above. If, however, the two sets of characters (colour and shape) are estimated together, the combined numbers will be found to give the following proportions—9 : 3 : 3 : 1. This may be illustrated from the writer's own experiments in confirmation of Mendel's work. Round yellow peas were crossed with wrinkled green, and in the second generation the four kinds of peas found in the pods were separated out and counted. The respective numbers were—

Round Yellow.	Wrinkled Yellow.	Round Green.	Wrinkled Green.
588	196	199	66

Mendel cultivated his strains for a number of years, and he found the characters so constant that he was led to regard them as having been transmitted in their entirety by structural units which could be thought of in much the same way as the chemist thinks of the atoms and molecules of which his compounds are constituted.

It is interesting to speculate whether Mendel's units can have any

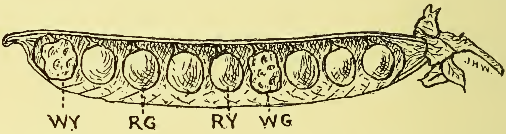


Fig. 2.—Hybrid Pod with peas of four different kinds. WY, wrinkled yellow; WG, wrinkled green; RY, round yellow; RG, round green.

recognisable material existence. Great advances have been made since his day in our knowledge of the processes resulting in fertilisation of the egg cell. It is universally admitted that fertilisation consists in the fusion of the nuclei of the pollen grain and the egg cell. The nucleus has been studied with great care, and at present it is believed that certain thread-like parts of the contents, the chromosomes, are the bearers of the hereditary features of the parents. It is to be expected that much light will before long be thrown on the problems of hybridisation by further study of the highly complicated and extremely minute bodies present in the nucleus.

Mendel's principles have been found applicable to a very considerable number of plants, but it is quite certain that they are not applicable to all, at any rate not in the simple and readily appreciated way illustrated by peas. It is well that the practical hybridist, who is more concerned about getting hold of a good commercial variety than in demonstrating a scientific theory, should keep Mendel's law in mind. Where it can be applied, it will give him assurance of fixity of type, and save time in reaching reliable results. By means of the method indicated above, he ought to be able to see at an early stage of his experiments whether Mendelian segregation is taking place or not. If it is taking place, he will immediately take advantage of the fundamental fact that the pure recessives and the pure dominants breed true to the character or characters he is most interested in, and he will

take pains to calculate whether it is worth while to face the trouble of fixing certain characters as yet unfixed. If he fails to detect Mendelian segregation, he has still recourse to the system which has been so long in force, and which we have to thank for the countless useful and ornamental hybrids of our farms and gardens, *i.e.* the simple and arbitrary system of selection of the desirable, and elimination of the undesirable, types resulting from crossing.

Natural hybrids.—There are many well-known examples of natural hybrids, that is, hybrids which have appeared without the aid or intervention of man. The wonder is that they are not commoner than they are. As a typical example we may cite the oxlip, which is a natural hybrid between the primrose and the cowslip. It is of fairly common occurrence, where the two parents are growing together, the pollen having been carried from the one to the other by insects. The willows are very subject to cross-fertilisation, because they are diœcious, that is, one tree bears the staminate and another the pistillate catkins, fructification of any kind being impossible unless insects carry the pollen from one tree to the other. When different species of willows are growing together, it is easy to see how readily crossing can take place.

Many natural hybrids have arisen in the garden and field. One of the most interesting of spontaneous garden hybrids is the logan berry, which was found in a garden in California where two species of rubus, a raspberry and a bramble, were cultivated. The logan berry has very little of the raspberry in its constitution. It bears a plentiful crop of fruit, containing a large number of very healthy seeds. Strong seedlings are easily grown in numbers. They are quite like the parent for the most part, but they vary very much in their fruit-producing power, very few of them reaching the parental standard in that respect.

An interesting case of natural crossing between members of the genus *Brassica*, happened in the writer's experimental plots. Amongst a race of crossed turnips he had raised, there appeared a number of what he is certain must be natural crosses between the turnip and the curled kale. He had no curled kale in his plots, but it is not at all unlikely that the pollen was carried from plants in flower in the neighbourhood. The hybrids were of a type distinctly intermediate between the turnip and the kale.

Infertile hybrids.—As has already been stated, it was at one time a general belief that sterility was a common attribute of hybrids. It is the case that a great many hybrids are quite sterile, but it is equally true that a large number are perfectly fertile. Between those extremes are found examples of every intermediate stage. The most interesting series are those which are found in one and the same genus, *e.g.* *Brassica.* There is no difficulty at all in crossing members of the cabbage tribe with each other; crosses between yellow turnips and swedes can be accomplished, but not so readily, and crosses between more distinctly differentiated plants like the charlock and the cabbage are much more difficult to effect.

A quite common character of sterile hybrids is deficiency of pollen. Many of them can be made to set seed if the pollen of allied varieties or species is applied. In extreme cases of sterility the pistil is abortive also.

It is sometimes the case that the first flowers to open on a spike refuse to be fertilised. A comparable case is that in which a plant, growing too luxuriantly, refuses to bear seed. Such examples show how insignificant the contributory causes of sterility may be.

Requisite knowledge.—The plant breeder should have a clear conception of the kinship of plants. He will find that a sound knowledge of systematic botany will be of the utmost service to him. Plants may have a great superficial resemblance to each other and yet belong to entirely different natural orders. On the other hand, plants presenting quite different outward characters may have a very close family relationship. One well versed in systematic botany would not think it at all absurd to propound

Fig. 3.—Two hybrid Turnips and two plants, doubtless resulting from a natural cross with Curled Kale, all from the same hybrid turnip seed parent.

for himself the problem whether he could evolve a fruit intermediate between the strawberry and the bramble, between the potato and the tomato, or between the cabbage and the swede turnip, but he would refrain from announcing his intention of securing a cross between the potato and the Jerusalem artichoke, the orange and the apple, or the beetroot and the carrot. There is no reason, of course, why he should not try what seem to be "violent" crosses, provided they are within reasonable limits of

consanguinity, nor should he be deterred from trying again where other workers have failed.

Having acquired a good working knowledge of the relationships of plants, the hybridist must acquaint himself thoroughly with the biology of the flower. It is only necessary to compare, say, the flowers of the turnip and the bean, or the potato and the oat, to realise at once the extraordinary diversity exhibited in their structure. The chief requisite to success in hybridisation is to understand fully the mechanism of the flower about to be operated with. It is imperative to discover whether the flower is self-fertilising, that is, whether the pollen borne by the stamens surrounding the pistil will, without any outside aid, be deposited on the stigma and effect full or partial fertilisation. If it is found that the flower when left alone sets no fruit at all, the next step is to discover by what natural means fertilisation is accomplished. It is obvious that some agent must either bring about the contact of the anthers and pistil of the same flower, or carry the pollen from the anthers to the pistil of that flower, or from one flower to another. Having noted how pollination is naturally effected, the hybridist has to devise means to prevent this from being carried out. The turnip flower will serve conveniently to illustrate the matter. It is a perfect flower, that is, it has all the parts of the ideal flower, namely, sepals forming the calyx, petals forming the corolla, stamens which are the pollen-bearing organs, and the pistil which ripens to form the fruit. The turnip flowers are visited industriously by bees, the insects being attracted by the honey secreted by glands at the base of the flowers. To reach the honey, the insect cannot escape being thickly dusted with the pollen which is present in great quantity in the anthers. Passing to a freshly opened flower, the bee cannot but deposit the pollen adhering to its body and legs on the adhesive stigma which lies in the way to the new store of honey. If the pollen be from another flower of the same plant, self-fertilisation will be effected, but if from another kind of turnip, cross-fertilisation may readily ensue. It has yet to be discovered whether insect visits are necessary to bring about fertilisation. There is no reason to suppose that the wind would carry the pollen of the turnip from one flower to another. By excluding insects it is found that fertilisation does take place to some extent, this being due to the stamens coming into contact with the stigma. Before hybridisation can be deliberately effected, it is therefore necessary in the first place to prevent possible self-fertilisation by removing the stamens before they are mature, and, in the second place, to safeguard against the visits of insects which carry pollen from other flowers.

In the potato it is often the case that the stamens are abortive. When they are abortive, there is no occasion to remove them. Further, insect visits are so few that fear of them need scarcely be entertained. It is well, however, in most cases to take the usual precautionary measures.

In our cereals the floral mechanism is not so easily understood as in the plants above mentioned. The ears of the oat, the wheat, the barley, and the rye have all familiar distinguishing characteristics. It has been clearly shown that they are alike in one highly important feature, namely, that they are habitually and normally self-fertilising. It is not necessary that the flowers should open at all, and very often, indeed, especially in bad weather, they do not open. This is the first thing the breeder of new grains discovers when he begins his work, and he keeps it vividly before him when he fearlessly plants all kinds together in his plots. It was known to Shirreff, who states in his treatise on the *Improvement of the*

Cereals: "It is usual for farmers to consider wheat to be in bloom when the hulls of the anthers appear on the outside of the chaff, and to dread the effects of wind or rain at this stage of the plant's growth on the ultimate productiveness of the crop; but the hulls of the anthers being in

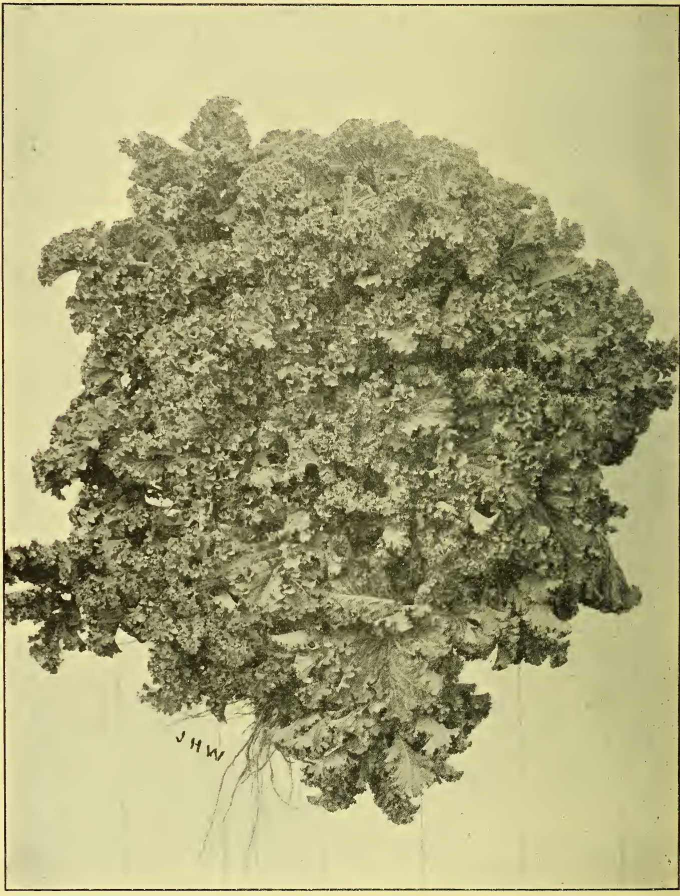


Fig. 4.—Derivative of Brussels Sprouts × Savoy, resembling Curled Kale.

such a position is evidence of the process of fecundation being at an end. . . . The opening of the chaff and ejection of the anthers take place only in fine weather, and are not essential to fecundation, a seed and decaying anthers being sometimes found in the same capsule." Seeing that the anthers invariably shed their pollen when still enclosed in the floral

coverings, either when not extruded at all or when being extruded, it is absolutely essential, as a preliminary to crossing, to remove them before they are mature.

Some Results.

New varieties of farm plants may be secured by simple selection, from among a number of plants, of examples which differ from the rest in presenting specially desirable characters. How such had come to be there is usually difficult to divine. In some cases they may be merely varieties

Fig. 5.—Series of Tubers, each from a different plant, but all having a common parentage.

such as one expects to see, especially amongst cultivated plants, or they may be varieties enhanced in vigour by one plant having been crossed with another, or they may be hybrids. It is an unsatisfactory method to grow different kinds of plants together in the hope that crossing may take place and yield valuable results. Some plants, of course, cannot be permitted to flower in the near neighbourhood of each other, the risk of intercrossing being so great. Foremost amongst such are the cabbage and its derivatives, *e.g.*, the savoy, Brussels sprouts, cauliflower, kale, etc. When they are crossed the progeny are an extremely heterogeneous lot, and of

very little service compared with their carefully bred parents. To take an example (in this case from deliberate crossing) of a cross between the Brussels sprouts and the savoy, the hybrid in the first generation was intermediate in form, being a savoy with sprouts on its stem. The progeny of this plant, however, in place of breeding true to that form, showed extremely striking variability, ranging from what was virtually a pure cabbage, through many types of coarse vegetables, to what could scarcely be distinguished from a curled kale.

The progeny of the cross between the swede turnip and the yellow turnip are also very diverse in character, ranging from what seem to be pure swedes on the one hand to pure turnips on the other. A large number of them seem quite indisposed to become fixed. The violent nature of the cross is further seen in the more or less sterile condition of many of the forms. When the sterility is pronounced, the plants, unexhausted by the production of seed, continue to produce flowering shoots until there is a close, twiggy mass of them.

Amongst potatoes one finds examples illustrating very many stages, from complete sterility to complete fertility, the lowest of the series including plants which do not flower at all, and the highest, plants laden with fruit. It is usual to find that when varieties with colourless skins are crossed, the progeny tend also to have colourless skins. When colourless are crossed with coloured varieties (purple, red, etc.), it is usual to find the progeny displaying a very considerable variety of colour. Other characters, such as the height of the stem, the form of the leaf, the colour of the flower, and the shape of the tuber, vary in similar fashion.

Since Mendel's laws were discovered a great amount of experimental work has been done in crossing cereals, in this country, on the Continent, and in the United States and Canada. It was very soon observed that the cereals were subject to Mendelian segregation. Wheat has received most attention. The short form of ear has been found to be dominant over the long form, the beardless condition over the bearded, and so on. When a long-eared beardless variety is crossed with a short-eared bearded variety the hybrid resulting has the ear intermediate in length and bearing short awns. Confining our attention to the two characters we are tracing, we find that if the plants are counted, with reference to the length of the ear in the first place, and then with reference to the presence or absence of awns, such numbers as the following are got:—

Plants Harvested.	Awnless.	Awned.	Short-eared.	Long-eared.
871	664	207	643	228

The grains from the bearded plants produce bearded progeny only, and those from the long-eared plants produce long-eared progeny only. Certain of the others when sown prove to be as distinctly hybrid as their hybrid parent, and reproduce the entire segregating series over again.

That Mendelian segregation takes place in oats can be illustrated by crossing a black variety with a white one and noting the colour of the grains of the progeny. In experiments carried out with two series of such, it was seen that in the second generation the plants could be separated into two groups as follows:—

Plants Harvested.	Black-grained Plants.	White-grained Plants.	Ratio of Black and White.
567	433	134	3·23:1
566	415	151	2·75:1

As was expected, when the recessives (whites) were grown no black oats ever appeared amongst them.

During the past few years, and more especially since the date of the recovery of Mendel's long-lost work, hybridisation both as a means of illuminating problems in heredity and in procuring varieties of plants of economic value, has been prosecuted with renewed energy by a largely augmented number of workers at home and abroad. It is certain that under the light which Mendelism gives, many of the mysteries of heredity will be revealed, and guiding lines of great practical importance laid hold of. From the great mass of scientific data now being gathered, the details of which are of interest to the specialist only, a code of rules will no doubt be drawn up, put in plain language, and made accessible to all who take an interest in the amelioration of our crops by crossing.

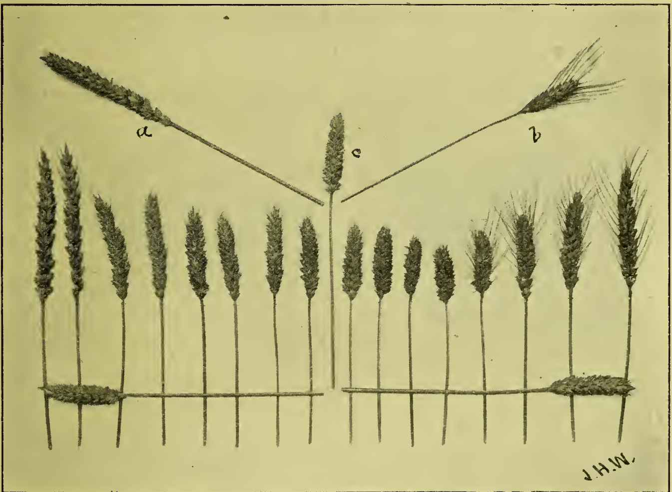


Fig. 6.—Series of Hybrid Wheats to show Mendelian segregation in the second generation ; *a*, beardless parent ; *b*, bearded parent ; *c*, hybrid (first generation).

The International Conference on Hybridisation, held under the auspices of the Royal Horticultural Society of London in 1899 and 1906, did much to show how practice and science can be brought to work together for a common end; but no organisation exists in this country for the express purpose of promoting the science and art of plant hybridisation. In the United States a Society, named the American Breeders' Association, was instituted in 1903. The members are drawn from the staff of the United States Department of Agriculture, the Agricultural Colleges, and Agricultural Experimental Stations of the United States and Canada, etc., and it bids fair to be a powerful instrument in carrying out the purpose set forth in its constitution, namely, "to promote the improvement of plants and animals by the development of expert methods of breeding."

In our country the hybridisation of farm plants has been largely carried on by commercial firms whose immediate object has been the raising of

new varieties of economic value. The commercial hybridist is seldom in a position to take an absorbing interest in the scientific side of the work, and in many cases he is naturally indisposed to disclose the methods whereby he may have possessed himself of a variety of high market value. It is the experience of all hybridists that in order to improve the plants we already grow, one must be prepared for very considerable expenditure of time, energy, and skill. If scientific inquiry, demanding the cultivation of large numbers of plants of no commercial value, is undertaken, the financial outlay may amount to a good deal. We look to our Universities and Colleges, aided by State and other endowment, to take part in a work the possibilities of which are so far-reaching and important. The interests involved are not only national, they are imperial.

Hybrids.—*See* Mules.

Hydraulic Ram.—This is a machine for lifting running water to a higher elevation by taking advantage of momentum and the elastic property of water. The original inventor was one Whitehurst of Derby, a mechanic, who constructed the first about 1772. He noticed, what must be familiar to most people, that on suddenly stopping the flow of water passing through a long pipe with considerable fall, that a heavy jar was produced within the pipe, occasionally causing it to burst. It occurred to him that this property might be taken advantage of, because the result of the sudden arrest of water was that its pressure momentarily increased enormously, and consequently if a small branch pipe be taken off near the tap a small quantity of water would be forced up it by the excessive pressure at the moment of closing that tap, to a height far greater than that from which the water originally fell. The elastic property of water also gives a recoil, which adds to the volume which can be raised. Whitehurst's ram was used for many years, until about 1820, when the French savant, Montgolfier, who improved the fire balloon, devised a plan by which Whitehurst's apparatus was made automatic, and greatly added to its practical utility. The ram has remained practically as Montgolfier left it, only minor alterations, however, considerably improving the efficacy, being made; and it is significant of the efficacy and durability of the ram that some of those of the original pattern fixed by Mr. Easton, who acquired the British rights to make from Montgolfier, are still working.

Where some 3 or 4 feet fall in a stream are available, a hydraulic ram developing a high efficiency can be utilised, and if well planned and executed will raise up to one-seventh of the volume of water entering the supply pipe to a height five times that of the fall. The essential parts of a hydraulic ram are a supply pipe acting as a flume, a discharge pipe, and a reservoir or air chamber; beyond these are two valves, one from the supply pipe to the reservoir, and one acting as a waste valve situated at a point in the supply pipe beyond the reservoir valve. When out of action the reservoir valve is in its seat, preventing flow from reservoir to supply pipe; and the waste valve is out of its seat, leaving a clear flow for water; on allowing the stream to rush down the supply pipe the waste valve is quickly driven into the seat and the water is suddenly arrested; the only escape for the water on the rebound is through the reservoir valve which is lifted from its seat, and a charge of water is driven into the reservoir; the pressure thus being taken off the waste valve, it falls, and a rush of water

through the waste pipe sets up momentum; meanwhile the reservoir valve having lost pressure from below, falls into its seat and prevents the water getting back into the supply pipe. The waste valve is closed again as in the first instance, and again the reservoir valve is opened, and a fresh charge driven through. Thus the waste valve closes and stops the flow of the water momentarily, sending a charge through the reservoir valve, each one opening and closing alternatively and continuously without any outside assistance; in fact the ram is entirely self-acting. The water which enters the reservoir or air chamber is forced up the discharge pipe leading from it by the pressure derived from the compressed air which is contained in the chamber, the air being compressed afresh with each injection of water from the supply pipe.

The ram should be properly protected from frost, and provision be made to prevent floating matter from entering the supply pipe, as sticks or other material may upset the working of the valves. Appleby, in *Handbook of Machinery*, gives as a guide to the efficiency of the ram the following data:—"If the ram is fixed at a reasonable distance from the point where the water is to be delivered, the fall necessary to deliver a given quantity is approximately as follows: About one-seventh part of the water will be raised to five times the height of the fall, and so on in the same proportion. Thus if the ram be placed under a head or fall of 10 feet, and the stream delivers 50 gallons per minute, about 7 gallons per minute can be raised to a height of 50 feet, or 3½ gallons to a height of 100 feet; or, in other words, an efficiency of 70 per cent. is obtained." The best forms of ram, however, show a greater efficiency than this. Falls as little as 1 foot 6 inches can be utilised effectively, and there is an actual limit to the increase beyond this, though, when it is sufficient to raise the water to the desired height, it is desirable not to exceed it, otherwise there is then an undue amount of wear and tear which naturally shortens the life of the ram. Water may be lifted to any practicable height, but the friction on the pipe increases with the length, and therefore makes the load proportionately more as the distance is increased.

The cost of installing a hydraulic ram is moderate in relation to its output, but it is of course dependent upon the local situation, the length of piping, the nature of the soil through which the piping has to pass, the amount of water which has to be lifted, and many other considerations. Once established, the automatic action and absence of need for frequent attention makes it a most economical means of raising water. A constant flow of water is, of course, necessary for a supply to be obtained at all times; it is, however, possible to utilise a small supply of pure water by the aid of a stream of less pure water passing the same place. On farms where the water supply is difficult to obtain from other sources than from running streams situated in low-lying portions of the holding, the ram is of special value, and might be profitably used with much greater frequency than prevails.

Impaction, Overcharge, Engorge, Overload, are terms applied to the overloading of some portions of the digestive track of the domestic animals. In the HORSE the parts mostly affected are the stomach, the large intestine (colon), and the rectum, the latter in the foal in particular. In the COW, the first stomach—*paunch* or *rumen*—and the third stomach or *omasum* are the compartments usually implicated.

In the PIG the stomach, large intestine, and the rectum are generally the seat of impaction, while the DOG suffers mostly from impaction of the rectum. In POULTRY the crop is, as a rule, the organ overloaded (crop bound).

THE HORSE.—The derangement mostly affects greedy or gluttonous feeders, usually on being fed after a long fast on too much badly cooked food, such as boiled wheat or oats, or it may be caused by the horse bolting its food without sufficiently masticating it, thus preventing the food from being properly mixed with the salivary juices; this latter cause is frequently seen in aged horses, whose teeth are at fault from irregular wear.

Symptoms.—As a rule, the horse is uneasy, paws the ground with its fore feet, showing slight colicky pains, or it may stand perfectly quiet, hanging its head, breathing quickly, with nostrils dilated, a tense fulness at the flanks, and patches of perspiration on various parts of the body, with an occasional regurgitation or belching of gas up the gullet. Cases also occur where a greedy feeder has slipped its collar and gained access to the corn bin, gorging itself with oats, Indian corn or other feeding stuff. Such cases, as a rule, terminate in laminitis or founder. On account of the walls of the stomach being so distended they become partially paralysed, and from want of tone to deal with the food the complaint is accompanied by fermentation and the generation of gas, which greatly aggravates the case.

Treatment.—When the animal is first noticed to be ailing, dissolve from 1 to 2 oz. of bicarbonate of soda in 1 pint of warm water to which add half a pint of whisky or 2 oz. of tincture ginger; give this as a drench, and follow up with 1 oz. of carbonate of ammonia and 2 drachms each of powdered nux vomica and powdered Barbadoes aloes mixed into a ball with a little treacle and water, repeating if required twelve hours after. If the belly is much distended with gas, causing great distress, it must be relieved by tapping with a fine trocar and canula on the right side, half-way between the last rib and the haunch bone; when accompanied by acute colicky pains, hypodermic injections (administering medicine through the skin) of atropin and morphia answer best; the stomach in these cases is too much overloaded for medicine to establish immediate action when given by the mouth.

Impaction of the large colon is mostly due to a too sudden change of food, *i.e.* from dry fodder to good grassing or *vice versa*, there being nothing worse than partially dried clover fog or too much oat straw. In these cases the walls of the intestine, like the walls of the stomach, lose their tone and become partially paralysed, and such may be termed true constipation of the bowels. The *symptoms* are somewhat analogous to those of the impacted stomach, but are not so oppressive, and are accompanied by colicky pains, but these latter are at longer intervals, the animal in the meanwhile lying a great deal, perhaps remaining perfectly quiet for two or three hours, occasionally screwing itself on to its belly, and when standing stretching its hind legs backwards as if in the act of urinating, now and again taking a bite of food, and although at the commencement the bowels may have been slightly loose, obstinate constipation sets in; there is no rise in the temperature, nor is the pulse affected; in fact at times the animal seems as if it ailed nothing.

Treatment.—Dissolve 3 to 6 drachms of powdered Barbadoes aloes (according to the size of the horse) in 1 pint of hot water, and when nearly cold add 1 pint of linseed oil, mix well together and give as a drench, emptying the rectum by the hand and giving as an injection half a gallon of warm water, to which has been added 2 oz. of glycerine; this may be repeated every four hours. A ball made of 4 drachms of carbonate of

ammonia and 1 drachm of nux vomica can also be administered every five or six hours, or until the bowels respond. When acute pain is present, hypodermic injections must be given. Impaction of the rectum is generally due to the want of tone in the walls of the bowel to expel the contents, and is mostly seen in aged animals, particularly breeding mares, whose bowel should at all times be examined and emptied of its contents prior to service, to prevent rupture. The rectum of the foal is at birth nearly always impacted with hard wax-like balls of various sizes, these being the first fæces or meconium; the foal presses and strains to pass the hard lumps, which if not ejected or removed become jammed in the pelvic bones and are liable to produce hernia or rupture; in such cases all that is necessary is to give an enema of warm water to clear the bowel.

THE COW.—The *rumen, paunch,* or *first stomach* is the largest compartment of the digestive organs in the cow, in the adult animal occupying nearly three-fourths of the abdominal cavity. The *rumen* is subject to impaction, *plenalvia, grain sickness,* etc., which is caused by various kinds of food, particularly when stall-fed on too much of the dry meals from the different kinds of grain, or from the animal accidentally getting to the meal ark and overloading the paunch with dry meal, gorging with potatoes, frosted turnips, or clover fog; any one of these cause over-distension, which is generally followed by partial paralysis of the walls of the stomach, arresting their peristaltic action. When the distension is due to the watery foods—clover, turnips, or potatoes—the *symptoms* are of an acute character, the belly being very much heaved up on the left side and distended with gas (hoven); this requires prompt treatment, and nothing is better than 1 to 2 wineglassfuls of turpentine mixed with 1 pint of raw linseed oil given as a drench, or 2 oz. of bicarbonate of soda dissolved in 1 quart of warm water, with 1 pint of whisky or 2 oz. of tincture of ginger added, and horned into the animal. Should this not give relief, the gas must be drawn off with the trocar and canula in a similar manner as recommended for the horse, but the operation must be performed on the *left side in the cow.* When the impaction is due to an overcharge of dry food, the symptoms are not quite so acute, the cow stands perfectly still with head extended, nose depressed, an anxious look on the face, the back slightly arched, and an occasional grunt being emitted; on pressing the flank between the last rib and the haunch bone, the stomach is felt to be full and doughy, it being possible to make an indentation on the contents of the stomach by a little firm pressure. The writer has never seen any colicky pains evinced, as is stated by others. Unless the overloading is extensive, there is rarely much acute disturbance, though the animal stops feeding and chewing the cud, and in the case of a milch cow the secretion is arrested. At first there is generally some slight diarrhœa, which soon gives way to constipation. This form of impaction is quite different to what is known as *stomach or grass staggers*; although slight head symptoms may be evinced, they never give rise to the great excitement seen in stomach staggers caused by eating rye.

Treatment.—At the onset, if there be much flatulency present, the linseed oil and turpentine draught, as already mentioned, can be administered, and two hours after 12 oz. of Epsom salts and 2 oz. of ground ginger mixed in 1 quart of thin oatmeal gruel, with another pint of raw linseed oil, the whole being horned into the beast as a drench; this medicine to be followed every eight hours, or until the bowels act freely with 2 oz. of hyposulphite of soda dissolved in 1 quart of warm water to which has been added 1 oz. each of mustard and sweet pepper, with the frequent

offering of cold water or cold hay tea to drink. Treacle ought never to be used in this complaint, as it has a tendency to cause fermentation of the contents of the stomach. In some cases the impaction is such that medicine has little or no effect, and ruminotomy has to be performed; that is, cutting a hole through the left side sufficiently large to allow the passing through of the hand, and removing the contents of the stomach with the hand. This should, however, only be performed by a professional expert.

Omasum, manyplies, manifolds, or the *third stomach* of the cow.—The lining membrane of this compartment of the cow's digestive organs is peculiarly arranged into folds or leaves, and in all cases of illness, particularly of a febrile nature, this stomach is liable to derangement, and when impaction takes place it is known by the names of *Fardel-bound* and *Lake-burn.* It may result from the same causes as impaction of the rumen or paunch, although there are other additional causes, and, as a rule, somewhat similar remedies can be adopted. It can be brought on by drinking too much cold snowy or frosted water, or in early spring from eating a mixture of old and new grass, also eating the astringent deciduous stipules — bud scales — of the oak tree or acorns, etc. The *symptoms* observed being that the animal stands in a stiff and dazed fashion, now and again emitting a prolonged grunt, with the horns and ears alternately hot and cold, muzzle dry and grinding of the teeth, the back slightly arched, and when pressed on the spine behind the shoulders the animal flinches very much and is likely to fall on to the knees, at the same time uttering a painful groan; rumination is entirely suspended, and, if the patient be a milch cow, secretion of milk ceases; slight diarrhœa may be present, but this soon gives way to constipation or stoppage. Owing to the impaction of the food between the leaves of the stomach it becomes hard and dry, and the leaves or folds partially paralysed and their functions arrested. This condition has been noticed in cases of stomach staggers, but it is also seen at the slaughter-house when cows have been killed in the best of health, therefore the dry condition of the contents of the stomach is more the *result* of the complaint than the *cause.*

Treatment.—When the animal is first noticed amiss and the nature of the ailment suspected, a good dose of opening medicine, Epsom salts and oil, such as is named under impaction of the rumen, can be given, followed up with a somewhat similar after-treatment, such as saline laxative medicine and aromatic cordials combined, with 10 to 12 oz. of linseed oil added, with hay tea to drink. When the bowels respond, and the animal seems improving, small quantities of oat sheaf, dry hay, cabbage leaves, etc., may be offered, and answer well in inducing the action of the stomach. Injections of warm water are practically useless, for, as a rule, derangements of the digestive organs in cattle affect the stomach more than the bowels, and enemas of warm water only aggravate the patient.

The Pig.—Pigs at times suffer from impaction or constipation of the bowels, the large intestine generally being affected; it is mostly caused by injudicious feeding with too much dry or badly prepared food, as an instance unsound Indian meal. Sows often suffer from this derangement just prior to, or immediately after, farrowing.

Treatment.—Of all the medicines that have been tried for constipation in pigs nothing equals croton oil, from five to ten drops mixed in 1 oz. of fine olive oil and put into the animal is the best remedy, and can be repeated in from twelve to twenty hours if thought necessary; warm water enemas to be given, per the rectum, every five or six hours, while 2 quarts

of cold water containing 2 teaspoonfuls of carbonate of soda can be put into a dish and offered as a drink, changing it every four or five hours.

THE DOG.—The rectum in the dog, as already stated, is the portion of the intestinal track mostly the seat of impaction, and this may be readily ascribed to the fondness that the dog has for chewing and eating such dry costive articles as bones, etc., the fæces usually being of a dry character and expelled with a great deal of straining. Sometimes the intestine is engorged, and on pressing the belly behind the ribs with the fingers the bowels feel hard and stiff and pain is generally evinced. In these cases the dog stops feeding, and when the rectum is loaded, frequent ineffectual attempts are made to pass the excreta, the belly is tense, and the poor brute walks with great stiffness and care. On oiling the finger and passing it into the bowel (rectum), a quantity of dry, rough fæcal matter can be felt, which must be removed with the finger aided by warm water and glycerine enemas. A draught composed of from 2 to 4 drachms of syrup of buckthorn and 6 to 8 drachms of castor oil mixed can be given as a drench; this dose being sufficient for an ordinary collie dog; other doses to be regulated according to the size and class of dog.

POULTRY.—The crop of the domestic barn-door fowl frequently becomes impacted, particularly when a gluttonous feeder has overloaded the crop with oats or other foods; when this occurs the bird is seen to be in a dazed condition, moping about and inclined to drink large quantities of water. On examining the crop it is found to be hard and over-distended. The quickest and best treatment is to cut into the upper third of the crop and remove the contents, washing it out with a little warm water, stitching up the opening, and feeding carefully for a few days.

Implements.—See the various headings under which the different implements used in agriculture are described, and the following article for their history and evolution.

Implements, Evolution and History of.—The development of agriculture to the present condition has been possible only through the aid of the engineer. Even in civilisations much earlier than our own there does not seem to have been any great development of machinery; while in countries little under the influence of modern civilisation, the implements still retain a pristine simplicity, and are such as are made by the blacksmith or carpenter. Even these possess the form which has been utilised in most modern cultivators, whether it be the plough, stirrer, hoe, or harrow, all of which, in simple form, are supplied by the branches of a tree. The plough is merely a development of a stout branch with a short hook at the end, to which steering and balancing handles and wheels, with a side-piece or breast to invert the loosened soil have been added; the latest great advance in tillage implements—the sickle-tine cultivator—has the same hooked form, a series of these tines being attached to a frame. The brush of the boughs covered in the seed, similarly, if inferiorly, to the harrow. The bole of the tree compressed or rolled the land. Up to a century and a half ago, machinery on the farm remained simple, and such as was made by the blacksmith. An endeavour to improve machinery was initiated in the middle of the eighteenth century, but evolution was necessarily slow, until rotary motion was availed of, and there was not much opportunity for this until the advent of the use of steam. However, such motion was applicable to wind, water, and horse power in some degree,

and the modern agricultural engineers' early forerunners were in evidence before the nineteenth century came in. However, even as late as the Royal Agricultural Society's first show, held at Oxford in 1839, the official report of the machinery gave it that the implements exhibited were for the most part "crude, cumbrous, and ill-executed machines, the work of village ploughwrights, and hedge-side carpenters." The rapid evolution of farm machinery dates from that show; and what went before is not of great significance, although the modern chaff-cutter and corn-drill had taken form in the inventions of Salmon just over a century ago. The parent forms of the reaping machine and threshing machine existed, though in a very crude condition, before the inception of the Royal Agricultural Society. It is not generally known among dairy farmers that the lactometer has been in use for over a century. Such machines, however, as were made were the result of genius handicapped by crude workmanship. The application of steam power influenced the improvement in the machinery of agriculture as of other arts, and brought the skill and science of the engineer to bear on farmers' needs, so that the cruder work of the blacksmith has gradually but rapidly disappeared. When once the rotary motion obtained from the steam engine was available, labour-saving machines became possibilities not merely from the application of steam to the particular agricultural machine, but because it made it possible to construct machines by which the farm machines could be made.

In the museum at Lewes is an Anglo-Saxon plough taken almost intact from a peat bed wherein it had lain for centuries, and apart from slight structural points it is identical with the Sussex hill plough of the present day. There are many farmers who, not altogether without reason, prefer the ploughing effected by ploughs of this type to that by modern ploughs. These ploughs invert the furrow without compressing it, the soil being lifted upwards and then turned over with a "broken back" from a moderate pressure given by the mould board. This allows a more thorough aeration than where the soil is turned by the steel breasts of the ploughs, commonly in use during the past fifty years. The common breast was invented by Samuel Taylor, a blacksmith of Cotton End, near Bedford, who conceived the idea by nailing a flat band of leather at one end and giving it a twist, so that as the soil followed it, as it was drawn along it was inverted. However, in this case the soil is but little lifted, and the moving aside and inversion of the furrow is done within the narrow space of the horse-walk, having the effect of drawing a wedge through a space too narrow for it; this results in an excessive amount of friction on the wing of the breast, on the front of the breast, on the land side (unploughed), and on the slade or bottom of the plough; in fact, so great are these that the draught of the common plough averages practically a third more than that of the modern digging breast plough, where a broken-back furrow is made. The chilled breasts of the digging plough are not necessarily so long as those on the "snake" ploughs, consequently there is less actual weight on the breast at any time. For wheat sowing the high-crested furrow closely compacted is preferable on some lands, but generally the digging breast is the most economical.

As long since as 1649 Walter Blyth described a double-furrow plough, and various improvements have been made from time to time, but they attained a small measure of popularity in Britain, probably because the British farmer requires deep ploughing entailing heavy draught, and the consequent use of a number of horses, which he objects to as treading the land. In the Colonies, where there is less regard paid to thoroughness

they are far more popular; in fact multiple ploughs, that is a framework carrying more than two bodies, are favoured. There is no doubt as to the economy of the double or multiple plough, but prejudice is difficult to overcome, though as gang ploughs they are easy to handle.

Digging machines have been very expensive to the introducers, as they have gained little popularity. They are practically rotary cultivators actuated directly from the engine, though the Darby digger, which consists of a frame carrying circular spades cutting clear at the bottom and having a stirring motion which effectually breaks up the land, is a variation from the general rule. The Cooper digger, in which a rotary motion is conveyed to a series of arms carrying long spud points, however, although possessing many features of the early diggers, is the most efficient in ordinary circumstances, and has done much to popularise this form of cultivation in recent years.

The cultivator, which is a development from the primary hand-hoe, has passed through many stages before it reached its present form of a slightly vibrating sickle-tine. Used to break up hard land, or to break down land previously ploughed, there is vast economy in the present form of cultivator as compared with its predecessors. Cultivation is mainly carried on to produce a friable seed-bed wherein the moisture is controlled to suit the size and strength of the seed and seedling plant. In producing a seed-bed it is desirable to aerate the soil effectually at all stages, and not to merely drag a tine through the ground, as was all that the earlier cultivators accomplished. The cultivator well illustrates the evolution of farm implements from the age of wood, through that of iron, to the present general use of steel. A century ago cumbersome heavy wooden frames carried stout iron tines; there was practically no means for altering the distance apart of the tines, and the raising and lowering was accomplished by lifting the whole frame and adjusting the travelling wheels. The set of the tines was so bad that they had to be kept into their work by the sheer weight of the frame. It is almost incredible that under the name of Brewer's drags these were commonly in use in Wilts and Hants twenty years ago, and may be met with even now. Finlayson in 1824 produced an iron-frame grubber with an improved pitch to the tines, and added a bell-crank to the front wheel, where by the aid of a lever the tines could be raised on turning the headlands. Various improvements were made, but generally a heavy frame was required to keep the implement working in hard ground. Probably the best of these rigid-frame cultivators was that made by Clay, for to some extent he foreshadowed the sickle-tine of the present-day implement, and was able to discard much of the weight of earlier makers. At the Leicester Show of the Royal Agricultural Society in 1896 Howard showed a cultivator which has been the forerunner of the many British sickle-tine cultivators since introduced, which have rendered the cultivation of land so much more economical and thorough than their predecessors. The broad principle of the sickle-tine is taken from the sickle-shaped tine of the hay horse-rake invented by James Hart, then blacksmith to the Duke of Bedford at Woburn, in the early "'fifties," and since universally used on horse-rakes. Hart also devised a means for raising and lowering the tines by means of a lever; the horse-rake has been frequently used to perform tillage operations, but the value of this form of tine for breaking up and stirring land is comparatively a recent discovery. A comparison between Martin's all-steel cultivator and previous forms reveals strikingly how little need there is for weight in the frame, provided the tines are set with the proper pitch to make them draw into the land. It will face the

hardest soils with no additional dead weight, and at the same time if meeting an immovable obstacle, by means of curved springs at the point of

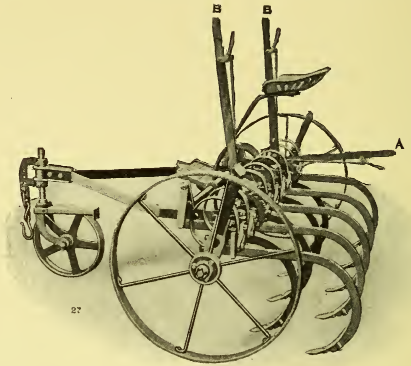


FIG. 1.—Martin's Sickle-Tine Cultivator as an ordinary cultivator.

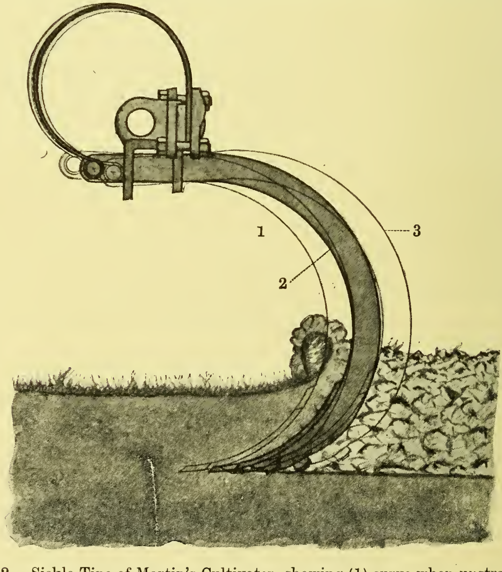


FIG. 2.—Sickle-Tine of Martin's Cultivator, showing (1) curve when unstrained; (2) yield when facing hard work; (3) yield when under exceptional strain—this being permitted by the strong spring, which is not affected unless an obstacle firmly embedded is met.

attachment, will give sufficiently to ride over it. The soil instead of merely having a mark drawn through it, as was so much the case in the

older implements, is actively worked and inverted, besides being pulverised by the vibration allowed by the spring. The introduction of this type of implement marks a decided advance in tillage operations, and it is difficult to recall one which has at any time been of equal importance to the tiller. Lighter cultivators and harrows, in which even greater elasticity is given

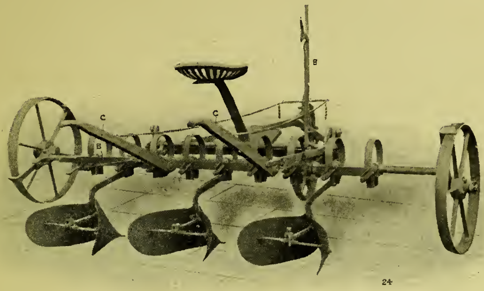


Fig. 3.—Martin's Cultivator as a three-row ridger.

by employing spring steel sickle-tines, are now commonly used, and after the land has been once moved, act as excellent tillers and cleaners; the extra vibration leaving the soil in a thoroughly worked condition. These are usually made in sections controlled by pressure springs which make them readily adapt themselves to inequalities of the ground. The modern

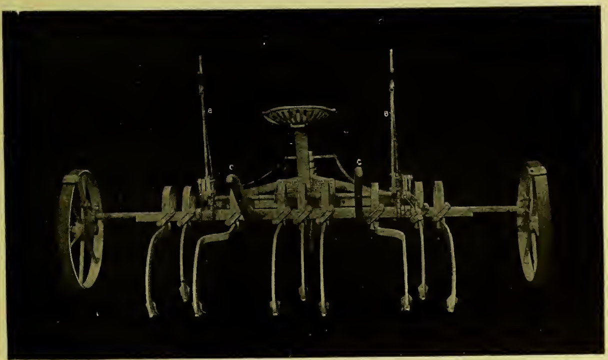


Fig. 4.—Martin's Cultivator as a three-row grubber for working between ridges.

cultivator lends itself readily to combinations and modifications. By merely substituting moulding breasts it becomes an efficient three-row ridger. By altering the position of the tines and adding sharp cutting blades, it is a good horse-hoe. A seed-box may be attached, and a corn broadcaster is made. The influence of the sickle-tine cultivator and harrow is probably not yet fully realised, although in such a short time their use has be-

come so general. The most striking effect is that in districts where the most primitive implements were in use they have succeeded in establishing themselves quite as readily as, if not more so than, in those where more modern implements were in use. The heavy wooden harrows which still hold favour in some districts at last seem likely to disappear, as they had done for a long time in other districts. These wooden harrows are of most primitive construction, heavy in draught, but by sheer weight pulled down furrows, and were preferred in these districts to ordinary zigzag iron harrows. It is as long ago as 1839 since Armstrong of Haynes, near Bedford, patented the zigzag form of frame which, until the sickle-tine cultivator was introduced, was employed on all many-tined harrows except those made of wood; and for harrowing in wide breadths of seed are still the most convenient. Chain or web harrows in various forms have been invented since Smith of Deanstone introduced the first in 1842. Of late years light flexible harrows have been introduced which, possessing long teeth or spurs, are convenient for harrowing young corn crops infested with charlock or other annual weeds, but there is nothing strikingly new about them.

Steam cultivation, from which so much was prophesied from forty to fifty years ago, has not realised the expectations of its sponsors, in spite of

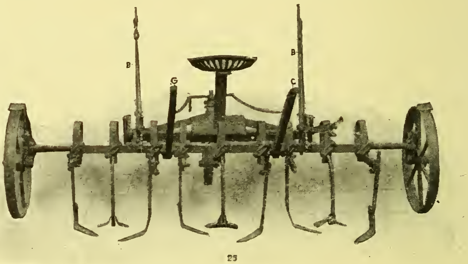


FIG. 5.—Martin's Cultivator as a three-row horse-hoe for root cultivation.

the work being successfully performed, whether in ploughing or cultivating the land. Its chief hindrance has been the great cost and the excessive weight to which it was necessary to build the engines to effect profitable work. The most successful work has been accomplished by the double-engine set, where the plough is drawn backwards and forwards across the field by engines placed on the opposite headlands; each engine having a windlass carrying a hauling wire-rope, one winding in as the other pays out alternately. Single-engine sets are capable of effecting good work, but though there are points in their favour, they have practically given way to the double sets. Automobile tractors with internal combustion engines have sufficiently established themselves to suggest that they will play a great part in the cultivation of the land in future, as well as perform most of the heavy operations of hauling, threshing, grinding, harvesting, etc., on the farm. It is some eleven years since Saunderson of Bedford first employed a specially designed 12 H.P. single cylinder motor for ploughing and other agricultural work. The Ivel Motor Company subsequently brought out a convenient form of motor, and earned the first R.A.S.E. medal awarded for a motor for agricultural purposes. In 1906 the Society marked the advance in agricultural motor manufacture by awarding its medal to Saunderson's

"Universal," now made with two cylinders giving 30 H.P., and with four cylinders giving 50 H.P. With the latter, multiple ploughs of from three to six furrows according to the nature of the work required, taking a breadth of 6 feet, and turning an acre of land in from forty to sixty minutes; cutting an acre of wheat when hauling two binders in a quarter of an hour; capable of hauling 12 tons on a good road; of threshing, grinding, in fact doing all the work of the farm commonly done by horses or steam, are possible. Much advantage is obtained in this machine by making the three wheels all driving wheels; which is accomplished by placing the two main driving wheels in front, and the third wheel behind, the steerage being performed by the front wheels, fitted with compensating gear. As all wheels drive there is practically no fear of slipping, because if either front wheel has a tendency to do so there are two wheels biting and the engine must advance. The agricultural motor has not the difficulties to overcome which assailed the steam engine in its first application to the work of the farm. The knowledge gained through the development of the steam engine, and the more recent experience in developing the road motor, have enabled makers to produce in this short time internal combustion engines of workmanship equal to the most modern steam engines. As they are workable on paraffin and other cheap oils, the cost of running them is so moderate that they must necessarily come into common use.

Drill husbandry received much impetus in England through the exertions of Jethro Tull, who lived in the eighteenth century, and who published his *Husbandry* in the earlier half of it. Previously, little had been done in the way of drilling, although Locatelli of Carrithia introduced a drill in 1662, which worked with some measure of success. Cooke, in 1783, produced the parent drill, which had as immediate successors Salmon's (Bedfordshire) and Smyth's (Suffolk), which in the main embodied the principles of the modern drill. Gradually they have been rendered lighter in draught and construction, so that during the past twenty years they have attained great perfection and leave little to be desired. Much of this results from having adopted ideas from American makers, who found that, in working on their prairie lands, the great weight appreciated in England was not necessary, and British farmers have realised that lighter drills are equally effective for their purpose. When wheat growing was of first importance in Britain a heavy coulter compressing the seed row was regarded as the first essential, and other considerations were little noticed, but since this crop has lost its popularity, and much of the heavier land has gone out of cultivation, drills more suitable for general purposes have become more popular. The more spud-like coulters of the American type, opening out rather than squeezing out a seed channel, have therefore forced their way into general use. Moreover, the gradual adoption of various types of force feed have done away the necessity for the heavy corn box of the cup drill. The lighter draught not only does away with the necessity for more horses, but avoids much of the trampling prejudicial to the seed-bed.

Manure distributors are practically machines of the past half-century, as concentrated manures were little used previously. The principles employed in seed distribution have been to a large extent used, and with certain developments have given fair results. The many different features in manures, however, make it far more difficult to distribute them than to sow grain and seeds; and it has only been within recent years, since means have been supplied to bring the manure to a series of rotary rakes working otherwise unimpeded, that distribution has been as satisfactory

as could be desired. Wallace of Glasgow and Coultas of Grantham have designed the successful machines, though they employ different means to bring the manure to the rakes. With either of these machines the supply of manure to the rakes is constant, and therefore distribution is even. Machines that distribute farmyard manure have been introduced, but as these involve the use of specially constructed waggons, they are but little used, especially where the manure is long.

From the hand sickle to the modern binder is a long stride, yet it is not a century ago since in 1812 Common of Denwick produced a machine with reciprocating knives with open finger guards, which may be regarded as the parent form of the modern machine. That there had long been a desire for something more efficacious than the sickle is shown by the fact that both Pliny and Varro mention reaping machines; these, however, were only rippling machines, consisting of a row of closely set prongs, which stripped the ears from the straw. William Pitt of Pendeford, at the end of the eighteenth century, brought out a rippling machine, the first British machine, in which a number of circular saws mounted on a common axis, and set closely together so as to form a serrated cylinder, snatched the ears from the straw and delivered them into a box. The Browns of Alnwick assisted Common and improved the machine, but in 1824 they went to Canada, taking models of the machine; after this they moved to Sterling in Cayuga County, New York State. From them M'Cormick of Auburn, about twenty miles from Sterling, obtained particulars, and Mr. Dan Pigeon stated that there is little doubt that the reaper competing at Auburn in 1846 was the child of those models and the father of the M'Cormick machine which obtained such notoriety at the London International Exhibition of 1851. Meanwhile the Rev. Patrick Bell in 1826 had introduced the endless apron to deliver the swath at the side of the horse track, and in 1849 Mason of Clinton, Ohio, used a second apron to deliver sheaves. In 1851 Seymour of Brockport, U.S.A., converted the swath delivery into a sheafer by using a reciprocating rake. In 1862 the "Dorsey" reaper, with sails to deliver sheaves, was brought to England, and was the first sheafer, except one more crudely devised by Salmon in 1806. In 1851, Watson and Renwick of Chicago added a string binding device, and it may be regarded as the forerunner of the modern string binder, although it failed in practice. Wood and Lock in 1867 brought out a wire binder, and many of this type were made, but the injury to cattle and milling machinery caused their abandonment. In 1889, Wood brought over a straw binder, but it was not sufficiently successful to compete with the string binder. The string binder shown in 1878 by the Johnston Harvester Company, and then applied to the Appleby binder, was to all intents the binder of to-day, although much improved upon in details. The vertical apron has been disposed of in some machines, mechanical contrivances being supplied to perform the work, and there seems no reason why this type of binder should not become universal, except that farmers are accustomed to the older type.

Haymaking machinery has developed in an extraordinary degree within the past twelve years. The ingenious Salmon invented a hay tosser or tedder in 1814, which in its essentials was similar to the rotary tedder still in common use. The Kicker tedder introduced some twenty years ago was an improvement on the rotary, as it was lighter in draught and more gentle in its action upon the hay. The modern swath turner, introduced by Jarmain at the Leicester Royal Show in 1896, opened up a new era in haymaking, and there are now many machines which perform the work

of making hay in the swath at a cost and with a perfection that was previously impossible. The swath turner, the agricultural motor, and the sickle-tined cultivator are the three great labour-saving introductions of recent years, and, apart from the mowing machine and binder, and the threshing machine, there has been nothing to compare with them in their influence on farming at the time. Side-delivery rakes in which the principle of sweeping is employed are modifications of the swath turner, possessing most valuable features. When the field elevator or hay loader is used in conjunction with the swath turner the work in the hay field is reduced to great simplicity, and instead of being one of the busiest periods on the farm it now can be got through with very little extra strain.

Although the flail held a strong sway up to thirty or forty years ago, and is still used to some extent, the bulk of the corn grown is now threshed by the threshing machine, the essential parts of which are a revolving drum carrying beaters working in a barred concave, which surrounds the drum for a considerable part of its circumference; the corn being threshed out by the stroke of the beaters and the rubbing action of the beaters whilst they are passing through the concave. Michael Menzies was the original maker of threshing machines, when in 1735 he introduced a machine

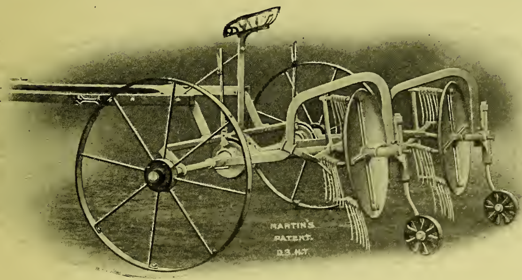


Fig. 6.—Martin's Swath Turner, to turn two rows at once.

which caused a series of flails to strike corn laid on a barn floor. Alderton in 1772 made a machine consisting of two rollers, one with cellular and the other with fluted surfaces, with the view of rubbing or spurting the grain from the ear. Winlaw in 1785 made a somewhat similar machine, consisting of two conical fluted rollers set vertically. All these were failures in practice. Meikle of Whitekirk, East Lothian, was the father of the threshing machine as now known, for he invented the revolving drum with beaters working in and against a concave frame. He added two fans for cleaning the corn from the chaff, also a hummeller. Rotary straw shakers were used for some time, but Docker of Findon claimed that in 1829 he brought out the modern straw shaker, and Ritchie of Melrose claimed to have done it in 1837. Once the principle of threshing was mastered, it would seem easy to devise efficient means to clean the corn and make the necessary separations, but the present efficient "finishing" machine was slow in its development, in spite of almost innumerable patents taken out with that view.

The larger number of animals kept in the yards, or of sheep fattened out on roots during winter, called for more expeditious machinery for the preparation of food than was provided by the simple hand tools in common

use a century ago. The early maturity to which modern live stock have been developed calls for feeding at high pressure, and at the same time without too severe a tax on the digestive organs, or too long a period absorbed in eating and so withdrawn from resting. The rotary chaff-cutter and the rotary drum with cutting sections for cutting roots, as in Gardiner's

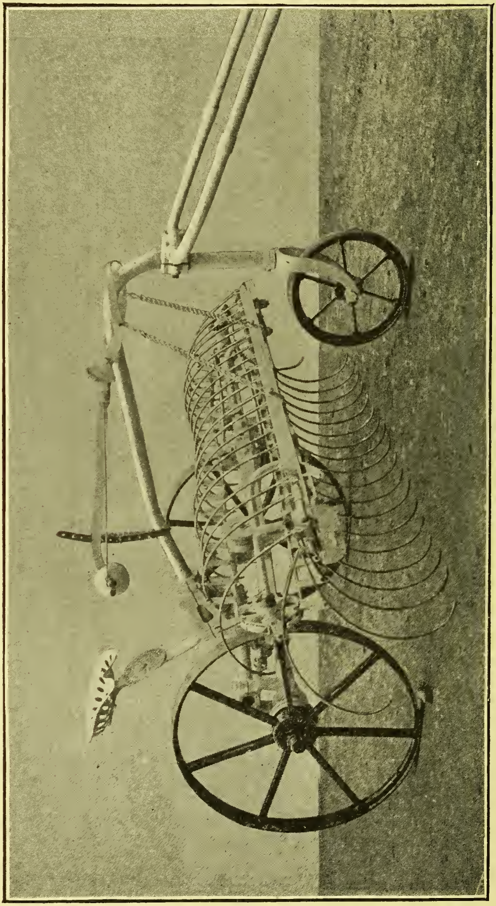


Fig. 7.—Blackstone's Side Delivery Rake, used as a hay collector.

The tines can be made to move from right to left, or left to right, or to remain stationary and so act as an ordinary horse-rake.

turnip cutter, were inventions which had a marked influence on cattle and sheep feeding, for by their aid farmers could economically supply their animals with a sufficiency of prepared coarse food in a form well suited to their requirements. The chaff-cutter of to-day, made with five or six blades attached to the radial arms of the cutting wheel, can chaff the straw into

suitable lengths for cattle, feeding as fast as it can be passed through the threshing machine; moreover, the work of feeding can be made automatical. It is doubtful if there is much real advance in root slicing since Gardiner's machine was introduced, although there has been a considerable number of shredders and pulpers brought out which do good work.

The introduction of feeding cakes called for something more expeditious than an ordinary hammer to break it into pieces sufficiently small to be eaten by animals, and the cake breaker, with a pair of spiked rollers for crushing it, well answers the work, though it is doubtful if farmers generally are careful to have the cake broken small enough to be properly digested; those machines with a double set of rollers—a finely-crushing pair below a coarser one—are preferable as ensuring better preparation.

Farmers are to be congratulated that so much sound engineering skill has been bestowed on farm machinery, and that the details of manufacture are so carefully attended to, for it is largely by these means that farm machinery has been rendered so efficient and simple, permitting untrained hands to take control of it with very little instruction. Manufacturers have, however, often been handicapped by prejudices on the part of purchasers which prevented and still prevent the application of more simple, lighter, and more effective means of performing certain work. Nothing, for instance, is more ridiculous than adhering to the heavy plough beams to carry a modern digging breast, unless it is that of so modifying the digging breast as to make it resemble as far as possible the old snake breast; yet manufacturers have been forced to do this very largely, because they could not sell the ploughs if they differed much in appearance from the ploughs to which purchasers had become accustomed. The success of light machines for doing many operations, not previously attempted until recent years, has done much to enlighten buyers, and it is satisfactory that during the last decade a very considerable part of this prejudice has disappeared, and manufacturers can now work with much greater freedom in design and idea than they could previously.

In-and-In Breeding.—*See* Heredity.

Indigestion, Dyspepsia.—A derangement or want of tone in one or more of the digestive organs, and the inability to deal with or assimilate the food. Indigestion may be acute, sub-acute, or chronic, and vary in degree in different animals, making itself manifest in a variety of ways according to the nature and the cause of the attack.

Horse.—Indigestion in the horse arises from several causes, such as injudicious or overfeeding, with an excess of improperly prepared food, as insufficiently boiled wheat or barley; both these cereals should be used when freshly boiled, on no account ought they be allowed to cool after boiling and then be warmed up again for food; this process induces fermentation, and is a common and dangerous practice. Horses bolting their food without sufficient chewing, irregularities of the teeth from uneven wear, casting of the crowns of the temporary or milk teeth, and bots in the stomach, are all liable to produce the derangement. When the bots are numerous they produce a morbid appetite causing the animal to eat large quantities of sand and earth; worms in the stomach have a similar tendency. Crib-biting and wind-sucking may be looked upon as forms of indigestion, while the eating of an excess of oat straw is a frequent cause. Seeing that the

derangement arises from so many different sources, there is a variability of the symptoms. In the acute form the horse stops feeding, and may have occasional slight colicky pains, pawing the ground with the fore feet and showing a great inclination to lie, accompanied by constipation of the bowels with occasional belching up of gas from the stomach, the inside of the eyelids slightly tinged yellow, the mouth fœtid and the tongue furred, yet with the pulse and temperature normal. In some cases the patient stands quietly, and will neither eat nor drink.

Treatment.—In cases as above, for an adult cart horse, 3 drachms each of powdered Barbadoes aloes, powdered rhubarb, and bicarbonate of soda mixed and made into a ball should be given at once, followed by 1 oz. of either bicarbonate or hyposulphite of soda; if the bowels are sluggish, the latter for preference; this, after being dissolved in a pint of tepid water to which has been added 1 oz. of tincture of ginger, to be administered as a drench night and morning until the bowels are acted upon, at the same time giving warm water enemas every eight hours, if required, and the animal tempted to eat by the offerings of small quantities of nicely selected hay or oat straw, or a handful of oats with a sliced potato or carrot mixed amongst it. In such cases soft boiled foods or mashes are loathsome and ought not be given, cold water and hay tea may be freely offered.

In the chronic form the horse gradually drops off its food, becomes languid and lazy, hangs the head, while the coat seems unthrifty and hoofs dry and brittle, skin dry, dung hard, in small pellets and frequently coated with mucus; at times slight scour or diarrhœa being present, pulse rather quick, and the inside of the eyelids of a dirty yellow, a stinking breath, and the tongue thickly coated; if any acidity be present in the stomach, the patient will occasionally be found licking the walls of the box. This class of cases is mostly due to overfeeding the horse for sale or show purposes with badly blended foods, *i.e.* of too starchy a nature, as an excess of wheat, barley, Indian corn, etc.

Treatment.—For subacute or chronic cases, a somewhat similar ball, as named for an acute case, should be given at the onset, to be followed by 1 drachm each of powdered Barbadoes aloes and nux vomica, and 2 drachms each of bicarbonate of soda and carbonate of ammonia, mixed and made into a ball with the aid of a little soft soap, and given night and morning or until the bowels seem active. The animal should be tempted to eat with the foods named under the acute stage, supplemented with grass or other green food, the cuttings of green fresh gorse (whins) or the new shoots of thorns; both these latter act as splendid tonics, and are much relished by the patient. In both the acute and chronic forms vegetable tonics such as quinine, gentian, and calumba may also have to be administered, either alone or combined with alkalies, or preparations of iron.

Cattle.—For indigestion of the cow, *see* Impaction, where the cause, symptoms, and treatment of the derangement of the rumen and manyfolds are fully recorded.

Calves.—Indigestion is a very common ailment in young calves, and is mostly due to the cruel and injudicious mode of treatment and feeding, inducing that well-known scourge called *White Scour*. Treatment and prevention are simple, namely, feed four times a day instead of twice, with small quantities of milk, adding to the evening meal 1 tablespoonful of Gregory's powder or 1 teaspoonful of bicarbonate of soda, or 1 wineglassful of lime water, or feed the calves from an indiarubber foster-mother, and let them suck the milk instead of drinking it.

PIG.—For indigestion in the pig, *see* Impaction for full particulars.

DOG.—Although the dog is, as a rule, a ravenous feeder, at times cramming his stomach with filthy, raw, or putrid matters, he has the aptitude of readily ejecting the contents of the stomach when overloaded, and does not seem to suffer from his guzzling habits, as would be expected. Old, fat, and pampered dogs are the greatest sufferers from indigestion, which is generally brought about by injudicious feeding. The symptoms are a morbid appetite, foul breath, and a great fancy for eating and chewing foreign bodies, rope, rags, wood, feathers, leather, etc., accompanied by a costive condition of the bowels. When this is noticed the dog should be sparingly fed on simple food, and as medicine a pill should be made up as follows and given as one dose every second or third day if required: 8 to 10 grains each of powdered aloes, rhubarb, bicarbonate of soda, and extract of gentian, or three Cockle's antibilious pills may be given instead. These doses are for a large-sized collie dog or spaniel; other dogs must be dosed proportionally according to their class, size, and age.

Inflammation.—This term, applied to the lower animals and also to man, has been very generally used in a more or less loose and indefinite fashion. One is accustomed to hear such expressions, as the horse or cow is suffering from "inflammation" or "*the* inflammation"; "the inflammation is being driven from one part of the body to another"; "no two inflammations can exist in the body at the same time," as though it were some specific disease or had some bodily form. By some it is regarded as synonymous with "fever," while by others the word is used to denote some disease which is probably known by other special names. Thus Youatt in his work on *Cattle* says, "When inflammation embraces the whole of the system, it assumes the name of fever," and describes "Black Quarter" under the heading "Inflammatory Fever."

Inflammation is properly used to denote a series of changes resulting from the injury of blood vessels and tissues of any part of the body. Such injury may be brought on mechanically by any actual violence—as, a blow, by intense heat or cold, by powerfully acting chemicals as acids, alkalies, irritant poisons as arsenic, corrosive sublimate, etc., and by microbes and their poisonous products. By whatever agency the changes may be brought about, the walls of the blood vessels in an inflamed area are so affected as to allow of the escape of some of their contents into the surrounding parts. Usually only some of the liquid and the white corpuscles pass out, though in case of severe injury red corpuscles are found. In those inflammations due to microbes the changes may be regarded as the result of a battle between them and the white corpuscles, the defenders of the body from harmful invaders, and the nature of the inflammation and its result will largely depend on the nature of the microbe and the power of the white corpuscle to overcome and destroy it. Certain bacteria in the struggle produce more or less deadly poisons, which may destroy and break down the parts producing ulcers, etc., or which, becoming absorbed into the blood, attack the vital powers of the animal. The germs of cattle plague, swine fever, anthrax, and many others may act in this way.

The local signs of inflammation are redness, heat, swelling, and pain. The general or constitutional symptoms depend on the cause, the part affected, and the extent. Any organ or part of the body may be the seat of the process, and though, when inflammation affects any considerable area, the general bodily temperature is more or less elevated, and some of the

symptoms of fever are present, the manifestations vary so widely with the part affected, that it would not be practicable to refer to them here.

Of inflammation of external parts visible during life, it may be stated that the *redness* is due to dilatation (enlargement) of the vessels, and the increased quantity of blood passing through them in any given time, circumstances which are by some authorities regarded as the cause of the extra *heat*. The temperature of an inflamed external part is usually appreciably higher than in health, or than the other external parts, but the heat of any inflamed part is not much, if at all, higher than the internal temperature as taken by the thermometer in the usual way. The degree of redness and heat will to a large extent depend on the number of vessels in the affected part, and the severity of the injury. The *swelling* is to a slight degree due to the enlargement of the vessels, but mainly to the collection of materials escaped from them. The *pain* arises from pressure of the inflammatory products on the nerves of the part, and possibly their special condition resulting from the irritation of these products. The *degree of swelling* depends on the severity of the injury and the vascularity of the part, and particularly on the distensibility of the tissues. In a part whose tissues are loose, as the dewlap of the ox or flank of the horse, the swelling may be great, even though the injury be not severe, whereas a much more severe injury to the very numerous vessels inside the hoof produces no swelling there, because the density of the horn will not admit of it. The *degree of pain* to a large extent depends on the same conditions, but inversely the firmer or more dense the tissues of or about the inflamed part, the greater the pain, as witnessed in inflammations under the human finger nail, or the horse's hoof, but the nerves in some parts are much more sensitive to painful impressions than others.

Many local inflammations are associated with bacteria which produce matter or "pus." These microbes are attacked by the white cells which pour out of the blood vessels in a remarkable manner; if in the deeper parts of the skin, or structures beneath it, these cells, the liquid from the blood vessels, and the microbes accumulate, and so form *an abscess* which tends to increase in size, and the contents to press so as to cause some softening and bulging at the part where there is least resistance. The usual signs of ripening of an abscess on an external part are softening of one part, so that, on being compressed with the finger, a depression is left, the hair falls out, a little moisture may appear on the surface, and finally it bursts at this spot. If the process is rapid, the abscess is said to be acute or hot, while if slow, the term *cold abscess* is applied. Inflammations do not invariably end in abscess formation. The material poured out from the blood vessels may be great and the swelling extensive, but if there are no microbes present, or if these are soon overcome by the white cells, the inflammatory product may all become absorbed, and the swelling dissipated.

The products of inflammation of the mucous membranes, that is to say, the linings of the surfaces of the nostrils, wind-pipe, bronchial tubes, the mouth, œsophagus, stomach, and intestines, womb, bladder, and male and female passages, etc., are usually thrown off from the surface as discharges. This condition is known as "catarrh" or catarrhal inflammation. At other times, the material coagulates on the surface of the membrane and may remain there as a *croupous* deposit, or be thrown off in flakes which appear in the discharge. Again, the last named may be associated with the death of the affected part as in diphtheria of man, when it is termed diphtheritic inflammation. This may be observed in swine fever, but attention is here drawn to the point, because it is occasionally observed in farm animals,

poultry, wood pigeons, etc., and there has been a disposition to rashly conclude that all such inflammations are manifestations of human diphtheria.

The *treatment* of inflammation in accessible parts will, to some extent, depend on circumstances. The effects of *heat* and *cold*, though produced in opposite ways, are very similar; both should be applied, not only to the inflamed part, but for some distance around it. If this method is adopted, both lessen pain by lowering the blood pressure in the part; but in this respect probably hot applications are superior, as heat of such a degree as can be safely used is of itself sedative and comforting. Hot water favours swelling, and so hastens the "ripening" or maturing of abscesses; but in cases in which permanent swelling is liable to occur, as in injuries to the elbow or hock, etc., cold appears preferable to hot. In treating inflammation, anything which would intensify the injury must be avoided, and, as a rule, the part should be kept at rest. The treatments of inflammation in connection with wounds will be found in the article dealing specially with them.

Influenza.—An epizootic (epidemic) disease or distemper, deriving its name from an Italian word or term; of a specific febrile character, and varies greatly in degree according to the nature of its attack, and the age, condition, and situation of the patient. Although as yet it has not been definitely determined, there is little doubt but that the malady is due to the effect of some specific micro-organism, aided by atmospheric influence. According to Hayes' translations of Friedberger and Frohner's *Veterinary Pathology*, and Williams' *Principles and Practice of Veterinary Medicine*, influenza, as affecting the horse, has been known as far back as the fourth and fifth centuries, and is recorded by different writers at various periods in accordance as the complaint made its appearance in various parts of the globe. In the fourteenth century it raged in Italy, in the year 1640 in Western Germany, and in 1711 in the eastern provinces of Prussia, while during 1829 it spread as an epidemic over the countries of Italy, Austria, Poland, Wallachia, etc.; and Gibson, a noted veterinary writer, observed it in London in 1732. It also raged epizootically in different parts of England in 1760, 1776, and 1803. From that time the chief epidemics occurred in the years 1813, 1815, 1827, 1836, 1840, 1846, 1851, 1853, 1862, 1870, 1881, 1883, and 1890 (Hayes). Williams records an outbreak in Toronto on the 1st of October 1872, in which during nine days the malady had attacked nearly all the horses in that city, and that, on the 18th October of the same year, it reached Montreal, and was prevalent all over Canada. On 14th October it was seen in Buffalo, on the 17th at Rochester, on the 22nd at Boston, New York, Brooklyn, and Jersey City, on the 27th at Philadelphia, on the 28th at Washington, and also on the 13th at Nova Scotia. The disease makes itself evident at all times of the year, but is most commonly seen in the cold spring months and wet autumns, but may, however, be met with in a very virulent form in hot summer months, while town horses, especially those kept in close, crowded, low-lying, badly ventilated stables, suffer more acutely than horses in the country. The complaint is of a highly infectious nature, and follows in the wake of horse dealers and market traders. Although all classes of horses are subject to its influence, young horses, say, rising three and four years old, when first taken up from grass, seem to be the most susceptible.

Influenza in the horse has an incubative stage of from about five to seven days, the duration varying in accordance with the nature of the attack, the constitution of the patient, and the environments. It occurs in both a simple and a complicated form, making itself patent in different stages,—*first,* as a SIMPLE CATARRHAL FEVER; *secondly,* CATARRH with CHEST COMPLICATIONS; *thirdly,* CATARRH and BILIOUS FEVER; and *fourthly,* as ŒDEMATOUS or EXUDATIVE CELLULITIS.

The *simple catarrhal* form resembles very much a common cold, and is usually ushered in by a slight shivering fit, which may or may not be noticed. With little or no constitutional disturbance or rise of temperature, the animal goes partially off its food, is dull and languid, with hanging head; ears and legs cold, especially the front of the knees and the back of the hocks; eyelids closed, and a watery discharge running from them and the nostrils, which as the case progresses becomes thick and mattery (muco-purulent), breathing slow but heavy, coat staring, bowels costive, the dung dry and in small hard pellets, and the urine high-coloured and scanty. Immediately those symptoms are observed, the horse should be laid off work, and put into a roomy, well-ventilated loose box, on a good bed of straw; the body sheeted with warm woollen rugs, and the legs bandaged, at the same time a pailful of cold water or cold hay tea placed in the box, and in which has been dissolved a heaped-up dessert-spoonful of either nitrate or chlorate of potash for the animal to drink, and at the same time small quantities of well-boiled barley and bran containing a cupful of treacle or soft sugar offered to eat, and this may be varied by a handful or two of mixed dry oats and bran with a few pieces of cut carrot or potato added, small quantities of nice selected hay and green foods, grass, gorse (whins), thorn shoots, etc., in fact anything the animal seems to relish, and in addition a lump of rock-salt should be put into the manger for the patient to lick. Should the discharge from the nose be much, steaming the nostrils with the following is highly beneficial: sprinkle a dessertspoonful of eucalyptus oil over the surface of a small bundle of hay, put into a pail, and over it pour a quart of boiling water, then hold it in front of the horse's nose, letting the patient inhale the fumes for twenty minutes, three or four times a day; at the same time the nostrils ought to be washed with warm water containing a little Condy's fluid, vinegar, or Sanitas. For simple cases the foregoing treatment and good nursing may be all that is necessary.

In the *second stage* or when the catarrh is associated with *chest complications,* when the bronchial tubes, pleura, and heart are implicated, the symptoms are much aggravated, accompanied with general prostration, quick breathing, nostrils distended, joints cracking on the slightest movement, eyelids closed and the insides red, mouth hot, temperature up to 105° or 106° Fahr., pulse quick and small; legs and ears cold, bowels costive; throat tender, etc. etc., the animal must be looked after as named under the simple form, *i.e.* isolated and moved into a good, airy, loose box, free from draughts; body clothed, legs bandaged, and its general comfort attended to.

Treatment.—Although in all cases of chest complications accompanied by general debility it is always dangerous to use purgatives in the horse, yet at the commencement of the illness nothing tends to give so much relief as the judicious and careful administration of a mild laxative, and as a medium there is nothing better than from 1 to 2 oz. of either hyposulphite of soda or Epsom salts dissolved in 1 pint of tepid water to which is added 1 drachm of sulphate of quinine, and

this can be given as a drench every eight hours or put into drinking water or cold hay tea, until the bowels are gently acted upon. As the case progresses it may be necessary to apply counter-irritants to the sides of the chest, over the ribs behind the shoulders, such as two or three heaped-up tablespoonfuls of mustard mixed in half a pint of cold water and rubbed well into the skin, and then covered over with a piece of paper or cloth. Blankets wrung out of hot water and rolled round the body are sometimes resorted to, but the writer does not favour this, as if carried too far they become oppressive and annoying to the patient. Other medicinal agents for the relief of the chest have to be used in conjunction with those already alluded to, such as a wine-glassful of the acetate of ammonia, and two tablespoonfuls of sweet spirits of nitre, and in cases of great prostration half pint doses of brandy or whisky have to be given, mixed in equal parts of cold water, and finally vegetable tonics in combination with alkalies or the preparations of iron have to be employed.

The *third* or *bilious form* may crawl on for several days before showing itself, the animal gradually becoming weak and dejected; the symptoms are, however, not nearly so acute as those seen in the second or chest complications, the chief distinction being that the inside of the eyelids, mouth, and nostrils are of a yellow colour; the treatment is similar to that recommended for the two previous forms, with the addition of half drachm doses of calomel being given night and morning to the extent of four doses.

The *fourth stage* of influenza is that known as PINK EYE, or *exudative cellulitis*, and is recognised by the swelling of the eyelids and legs, while the inside of the eyelids, nose, and mouth is of a true pink colour. This form varies very much in degree, the early symptoms being analogous to those named in the former conditions, accompanied by the swelling of the limbs and head. Similar treatment can be adopted, but the hyposulphite of soda and quinine, as well as the chlorate of potash, can be used freely, also iodine and iron tonics. Good nursing, attention to the general comfort of the patient, and plenty of fresh air are very essential and important in all cases of influenza.

Iron in Soils.—Iron is so universally distributed in nature that it would be surprising if it were not present in soils. It occurs in all the metamorphic rocks, and most of the minerals which compose them in the forms of sesquioxide and protoxide. For example, it is abundant in hornblende, mica, and most of the felspars, as well as in the olivine group, and from them it passes into the crystalline rocks, such as basalt, trachyte, porphyry, granite, syenite, gneiss, and mica slate. On their disintegration through natural forces, it becomes a constituent part of clays, sands, and loams, and of the various classes of soils, whether formed *in situ* or transported. It imparts a red colour to clays and sands, where it exists as sesquioxide (iron rust), and a blue colour to subsoils where it occurs as sulphide and ferrous salts. Hydrated ferric oxide acts upon sandy soils as a cement, and is answerable for the formation of muir-band-pan. The presence of iron in soils confers special properties which are useful to vegetation. Ferruginous clays are known to absorb and preserve moisture in a hygroscopic condition. Iron also greatly assists in retaining phosphoric acid, and exerts a retentive power towards ammonia, potash, and other bases by forming compounds which are decomposable by water. From the soil, it passes into the plant, in soluble form, and occurs as an ingredient in the ashes of cereals, hay,

roots, and all descriptions of vegetation. From plants it passes into the animal system, and performs important functions in the red corpuscles of blood. It must be regarded as an integral part of the tissues of plants, and therefore as an essential constituent of all soils. It is present in farmyard manure and many artificial fertilisers, but is not generally regarded as a valuable material, owing to its general distribution. It does not, for example, occur in the lists of mineral matter removed by crops in the same category with phosphoric acid, potash, lime, magnesia, or of total ash removed from the soil by crops. Like silica, iron, so far as its manurial value is concerned, is usually viewed as a negligible quantity. It is only referred to once in Voorhee's *Fertilisers*, and that as a constituent of basic slag or iron phosphate, but no significance is attached to it as a fertilising element. Aikman does not include it in the six absolutely essential ingredients of plant ash, nor in the three additional possibly necessary ingredients. The Rothamsted Memoirs do not take iron seriously as a fertilising ingredient, but this indifference on the part of authorities does not detract from the actual importance of iron as a constituent of soils or of plants. Dr. Griffith alone among modern writers believed in the importance of iron salts for manurial purposes, but in this respect he was as "a voice crying in the wilderness."

That iron exerts a beneficial effect in soils is freely allowed by all, but its amount is so considerable, and the call upon it is so limited, that it is not a subject of commercial interest. The very wearing away of ploughshares and other cultivating implements in the soil, and its accidental presence in many manurial dressings, appear sufficient to keep up the supply were it lacking; but its presence is sufficiently evident in every red and yellow soil, and in every subsoil.

That iron acts as a carrier of oxygen is not only true in respect of the aeration of the blood in the lungs of animals, but is also equally true of the mutual relations of the atmosphere to the soil. Ferric oxides are carriers of oxygen, as they are readily reduced to the ferrous condition when brought in contact with vegetable matter. They in this way promote decomposition to a limited degree within the soil. Protoxide of iron is readily changed into peroxide when exposed to the air, and is easily deprived of its oxygen in contact with decaying vegetable matter. The operation may be repeated *ad infinitum*, so that ferric oxides of iron may be regarded as a vehicle by which oxygen may be absorbed from the air for vegetative purposes. We therefore conclude that, although iron may not possess active fertilising properties which impel its use, nor be an essential constituent of plants, nor a factor in soil exhaustion, it nevertheless plays an important part in fitting the soil for plant growth, and in the body of all plants as a food for animals and man.

An excess of sulphides and protosalt of iron are a sign of wetness, and frequently occur in bogs and undrained subsoils; and it is part of the improvement effected by drainage that these salts are peroxidised.

Muir-band-pan has already been mentioned, but deserves further explanation. It is due to the freeing of iron from organic combination through natural decay, often of heather. The iron sinks through the soil and gradually absorbs oxygen and changes into ferric oxide. The cementing power of this substance has already been mentioned, and it is due to it that sand and other mineral fragments become bound together in the form of a "pan" several inches beneath the surface. This interferes with the natural drainage of the surface, and requires to be broken up by subsoiling before the land can be brought into successful cultivation. (*See* Muir-band-pan.)

Irrigation consists in artificially flooding land with clear water, and must not be confused with "warping" or flooding with mud-laden streams. In true irrigation, the object is to stimulate growing herbage, while in warping it is to increase the depth of the soil by the deposition of mud. It is evident that the two ideas are antagonistic, for muddy water coats the leaves of growing plants with finely divided earthy matter and blocks the stomata. Clear water passed over bare land would sweep away fine particles and soluble fertilising matter. It is therefore evident that irrigation involves the use of limpid streams, while warping must be accomplished with the aid of turbid flood or tidal waters. The inundations of the Nile, and the improvement of land adjacent to the estuaries of rivers such as the Humber, are not to be classed with true irrigation. In this country irrigation is best illustrated by water-meadows, and, as further indicating the difference between the action of clear and turbid water, nothing is more injurious to these meadows than floods, which bring down enormous quantities of suspended matter and cloy the leaves of the grasses, in many cases rotting them.

The theory of irrigation is based upon the beneficial effect of running, in contra-distinction to stagnant, water. It is necessary that the fertilising stream should pass onwards, in order to be replaced by fresh supplies, and the plants are nourished by the soluble matter which the water yields up to them. The character of the water is of great importance. It is sometimes warmer than the air, but in all cases contains carbonic acid gas, nitrates, and mineral matter, which act as direct fertilisers. River water is the best, and some streams yield water exceptionally adapted for the purpose.

Want of space prevents us from considering the subject in its widest applications, but its importance in hot countries and in many British colonies is well known. We shall therefore consider it in its relations to water-meadows and arable land, but chiefly in the former, as the irrigation of arable fields is rare, except in connection with the drainage of towns (*see* Sewage).

Water-meadows are almost entirely restricted to a group of counties in the south and south-west of England, although it is difficult to see why this should be the case. These are, Wiltshire, Hampshire, Gloucestershire, Oxfordshire, Worcestershire, Dorsetshire, and Berkshire. The irrigated meadows always abut upon a stream, and the water is conducted from mead to mead, the tail-water of the higher-lying meadow becoming the head-water of the next, until it is returned at a lower level into the stream. The water loses none of its virtues by being repeatedly employed, and this may be explained by the fact that while it gives up its fertilising ingredients over one area, it collects fresh manurial matter from the soil, and from the voidings of cattle and sheep which have grazed upon the meadows previously.

At first sight it might be thought that the thorough drainage of land and artificial flooding or irrigation are opposed to each other in principle, but such is not the case. A good water-meadow must lie upon a porous subsoil, and those which rest upon clay or peat are always of inferior quality. The water employed no doubt passes through as well as over the soil, and carries its fertilising properties to the roots as well as to the leaves. Besides, the principle of thorough drainage consists in promoting the movement of water rather than in getting rid of it. Drainage has been described by one of its greatest exponents, as subterraneous irrigation, because a greater quantity of water (rainfall) passes through a drained field

than through one which is water-logged. There is no water-logging in a water-meadow, as the water is in constant movement, and in no danger of losing its oxygen and its many other fertilising ingredients, or becoming sour, stagnant, and charged with effete matter, such as marsh gas and sulphuretted hydrogen. A well-situated water-meadow is naturally drained, and allows of the free percolation of water; and, if not, it ceases to be of first-rate character.

The productivity of such meadows is extraordinary. In the first place it is exhaustless, for they are mown year after year without any applications of manure, excepting the water. When grazed with sheep, as is usual in the spring, the flock is always folded at night upon arable land, and consequently the meadow is robbed for the benefit of the adjacent fields. The hay is deported on to the farm, and its manurial residues are not returned to the meadows; and it is frequently sold. Such treatment would soon exhaust any dry meadow, but has no effect whatever upon the productive power of a water-meadow.

The annual routine consists (1) in eating off the early spring feed with ewes and lambs; (2) in mowing an abundant hay crop; and (3) in autumnal grazing, which is continued up to the end of October. The watering of the meadows naturally falls in with these arrangements, and is conducted as follows:

As soon as the cattle are removed in October the water carriages on the summits of the ridges, and the drains or "drawns" at the bottoms, are hacked, cleaned out, and repaired, and the "hackings" are carted away. The watercourses are cleared of weeds, and the meadows made up, after which they are watered on alternate weeks throughout the winter. They are laid dry in April, and the spring feed, which is then in a luxuriant state, is folded with ewes and lambs, the latter running forward. As soon as the sheep have finished, watering is resumed and continued week in week out, until about the end of June, at which time the grass should be ready for mowing. The meadows are then laid dry until haymaking is finished. They are then watered for the autumn feed, and again laid dry and grazed with cattle until the close of the season. There is always work in connection with the "hatches," "trunks," sluices, etc., entailing carpentering and chalk carting to repair the damages done by the trampling of cattle, and the wearing effects of water. The meadows are mostly kept level by treading rather than by rolling, but both means may be used to obliterate the footprints of heavy cattle.

The system of irrigation is complicated by the natural alterations in slope, but the water-carriers and drains are so arranged as to flood the entire surface. The water is taken from the stream by deflection, and weirs, and passes through sluices into the "main carry." It is tapped at intervals, and conducted through smaller carriages, and admitted by "trunks" and "leets" into the carriages, which run along the top of each ridge. The work of the waterer or "drowner" consists in guiding the water and regulating its flow, so as to secure uniform watering of the whole surface. These men are experts in all matters connected with meadows, and find employment most of the year in connection with them; but are ready to help in haymaking, harvest, thatching, and other descriptions of farm-work when not so engaged. The management of a system of water-meadows involves conflicting interests, which are usually settled in a neighbourly manner, but sometimes produce friction between the parties interested. As already mentioned, the water may be taken from the river, and, after irrigating a series of meadows, may be returned to the main stream miles below.

The productiveness of water-meadows has already been alluded to. In Wiltshire and Hampshire they are often let by auction for the season, for from £6 to £8 per acre, with liberty to remove the hay. The spring feed alone is worth £2 per acre. The hay crop will average from 2 to 3 tons per acre over all, but the produce is of inferior quality. The autumn feed may be worth £1 per acre. Taking the entire produce at ordinary rates, the annual gross return may be stated as follows:—

Value of spring feed	£2	0	0
„ „ $2\frac{1}{2}$ tons of hay at £2, 10s.	6	5	0
„ „ autumn grazing	1	0	0
Total	£9	5	0

Water-meadows are a valuable adjunct to a farm, and are usually included in the general rent without extra charge, *i.e.* at 15s. or 20s. per acre over the entire holding.

Quality of the water, climate, etc.—Clear water suitable for trout, and having a soft feeling, due to the presence of alkalies, has been mentioned as indicating water suitable for the purpose. A certain degree of warmth, above that of the air, is not infrequent in rivers and running water, and prevents frost from penetrating the ground. Many of the best irrigating streams are derived from the chalk formations of Hants, Wilts, and the neighbouring counties, and the Gloucestershire meadows are watered by streams from oolitic limestones. It has been pointed out that a slight scum on the surface is seen on waters suitable for irrigation, and this points to the presence of impurities of fertilising value. The passage of water over meadows upon which live stock have grazed must disseminate manurial matter, and bring it into direct contact with growing plants; and this accounts for the fact that the repeated spreading of water over successive meadows does not deprive it of any of its value. The presence of injurious matter from mines or manufactories is as injurious to plants as it is to fish, but a degree of contamination from towns and villages in the form of sewage must be beneficial to vegetation. The softening effects of potash, soda, and ammonia upon water are well known, and even lime in excess precipitates lime in solution. A "soft" water is thought best, and many of the chalk streams of Wilts, Hants, and Dorset are of this character. Climate is always an important consideration, and the natural or prescribed limitations of water-meadows in the country point out the south and south-west as pre-eminently suitable for this form of irrigation.

The herbage of water-meadows was ably worked out by the late Dr. William Fream, who had exceptional opportunities of observations at Downton College, on the banks of the Hampshire Avon, which waters some of the best water-meadows in this country. The herbage was found to be composed of 26 grasses, 7 legumes, and 53 miscellaneous species. In the list published in vol. xxiv., 2nd series of the Royal Agricultural Society's *Journal*, he pointed out that many of the species are the same as are found in dry meadows, and these he indicated by italics, as follows:—

1. Agrostis alba (marsh bent grass).
2. *Agrostis vulgaris* (*fine bent grass*).
3. Aira cæspitosa (tufted hair grass).
4. Alopecurus geniculatus (floating fox-tail grass).
5. *Alopecurus pratensis* (*foxtail*).
6. *Anthoxanthum odoratum* (*sweet vernal grass*).

7. *Avena elatior* (*tall oat grass*).
8. *Avena flavescens* (*yellow oat grass*).
9. *Briza media* (*quaking grass*).
10. *Bromus mollis* (*soft brome grass*).
11. Bromus racemosis (smooth brome grass).
12. *Cynosurus cristatus* (*crested dog's-tail grass*).
13. Festuca duriuscula (hard fescue grass).
14. Festuca elatior (tall fescue grass).
15. Festuca loliacea (ryegrass-like fescue).
16. *Festuca pratensis* (*common fescue grass*).
17. Glyceria aquatica (reed meadow grass).
18. Glyceria fluitans (floating meadow grass).
19. *Holcus lanatus* (*soft oat-like grass, or Yorkshire fog*).
20. *Lolium perenne* (*perennial ryegrass*).
21. Phalaris arundinacea (reed canary grass).
22. Phleum pratense (timothy grass).
23. Phragmites communis (common reed).
24. Poa annua (annual meadow grass).
25. *Poa pratensis* (*common or smooth-stalked meadow grass*).
26. *Poa trivialis* (*rough-stalked meadow grass*).

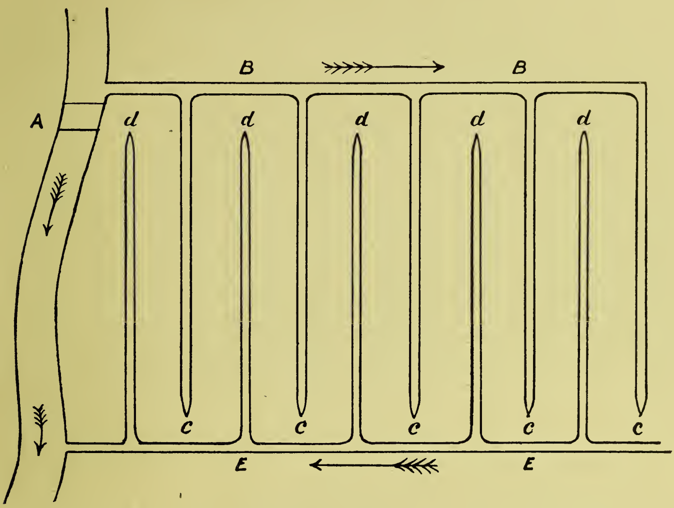
The grasses will be seen to form two groups of thirteen each, the names in italics representing the herbage found both in water and dry meadows, and those printed in ordinary type, found exclusively in water-meadows. "Of these, Holcus lanatus or Yorkshire fog is first in point of quantity, the second place in this respect belonging to either Bromus mollis or Lolium perenne. It is noteworthy that Dactylis glomerata (cocksfoot) does not occur upon these water-meadows." Besides the above grasses the following leguminous plants were found:

Lathyrus pratensis (meadow vetchling).
Lotus corniculatus (bird's-foot trefoil).
Lotus major (greater bird's-foot trefoil).
Medicago lupulina (trefoil).
Trifolium pratense (red clover).
Trifolium repens (white clover).
Vicia cracca (tufted vetch).

The herbage of water-meadows is coarser than that of dry pastures, and often abounds in "flag" or yellow iris and reeds, especially when the drainage is defective. The roots lie very near and often above the surface, and after mowing can be seen as minute white filaments at the base of the stalks, evidently being attracted by the abundant supply of water.

Construction of Water-Meadows.—Probably most of the existing water-meadows owe their planning and construction to Dutch engineers. It is noteworthy that water-meadows are not referred to in Lisle's *Observations on Husbandry*, which were collected with the utmost minuteness between the years 1693 and 1722, almost exclusively in Hampshire. Neither under Hay, Meadows, Pastures, or any other heading are they even alluded to. They are, however, described in the Agricultural Surveys of the Board of Agriculture at the beginning of the nineteenth century. Lisle could scarcely have omitted all mention of a system of irrigation so closely connected with the agriculture of his county, and this omission points to

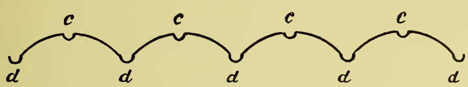
the conclusion that water-meadows must have been mostly formed subsequently to 1722 and during the eighteenth century. Youatt states that irrigation was first introduced into England at the very end of the seventeenth century, and this might account for its being unknown to Lisle. It is a matter of history that Sir Cornelius Vermuden, an eminent Dutch



Plan of Water-Meadow.

A, Dam across the river.
B, Main carrier.
c, Gutter or "carrier" along top of ridges.
d, Draining gutters.
E, Main draining gutter.

engineer, was appointed by Charles I. in 1642 to drain the district around Axholme, and it is related that two hundred families of French and Flemish Protestant refugees settled in the district. It is probable that these refugees spread the knowledge of irrigation; and towards the end of the century

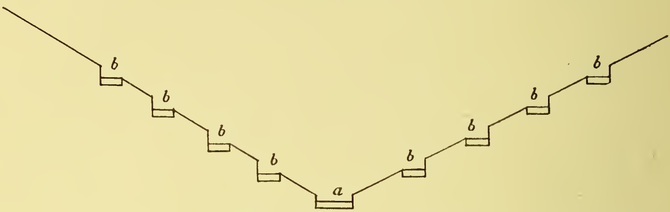


Section of Water-Meadow.

and later were engaged in constructing water-meadows in Gloucestershire and other counties.

The first work would be to survey and ascertain the levels, and the next to plough the land in various directions indicated by the levels, and finally to arrange for the sowing of grass seeds and the watering of the ground. The above plan of a water-meadow will assist the reader in understanding the general arrangement.

Catch Water-Meadows.—In these meadows a slope is required. The head-water is taken off at a high level and conducted along gutters cut in the hillside. The overflow runs over the surface and is caught in each



a, Stream (tail-water). *b*, Gutters.

successive tier of gutters until it finds its way to the stream, which carries it back to the original source at a lower level. This system is well worth adopting when the contour of the ground allows of its being carried out.

Italian Ryegrass.—*See* Ryegrass.

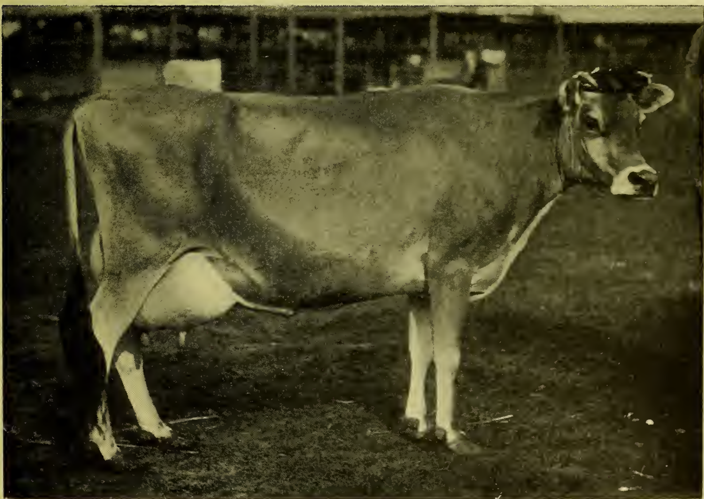
Jersey Cattle.—The number of first-class dairy breeds of cattle in Europe is quite limited. The famous breed of Holland, black and white in marking, and known in England as the Dutch and in America as the Holstein-Friesian, perhaps stands first of continental breeds, but she is closely followed by the Braunvich and Simmenthaler cows of Switzerland, the Flemish breed of Belgium, the Jydsk and Angeler of Denmark; and yet, if we take them all at their best, the choice varieties of British stock we place before them all. It is true that the Holstein is hard to beat for quantity of milk, but she is neither a rich milker nor a maker of good beef, while every other breed we name, the Angeler excepted, while yielding a large quantity of milk of average quality, finds her last home in the abattoir.

Among the British breeds of dairy stock some place the Jersey first, and yet the farmer finds most money, as he says, in dairy shorthorns, unless in those localities where other breeds are kept, and there we find the dominating breed is Devon in the west, red polls in East Anglia, Ayrshires in the dairy parts of Scotland, and the Kerry in the south of Ireland. Just, however, as the shorthorn is unique in its peculiar way as a general purpose cow, so is the Jersey as a maker of the richest milk and butter. If we travel throughout a large proportion of our English counties we shall find no trace of Channel Islands blood except upon the farms of amateurs, or now and then on those of tenant-farmers.

There are perhaps more Jerseys kept within 20 miles of London or from London to the sea, than in the rest of England. As cows have been imported from the Island in the past, they have spread through Hampshire to the west, and owing to their attractive form and colour, their gentle nature and rich milk, they grace the parks and pastures of the titled and

Parsons.

JERSEY BULL.



Parsons.

JERSEY COW.

the wealthy, especially within reach of the Metropolis. Little has been done by those who keep the breed—a few excepted—to help in their improvement. Bull calves are sold and heifers kept almost without regard to blood or milk production, and thus a herd is kept for years without the least progression. In the judgment of the pick of Jersey breeders the calf should prove a better milker than its dam. By breeding every year from better stock, *i.e.* from cows which give the highest yield of milk and bulls bred from similar cows, improvement is effected, but if we leave the choice to nature or to man who makes no study of his work, we get an opposite result, and retrogression follows. Of all the thousands who own Jersey herds we honestly believe there are not fifty men who breed on scientific lines and spend their money in the right direction. The skilful breeder buys stock only to improve his own, those which he drafts are culls, his standard is his own and that he strives to reach, but the nearer he approaches it he lifts it higher. The careless breeder leaves his thinking to his man, and so he fails until he seems to recognise a Jersey cow as anything of Jersey colour with an udder and four teats.

The best type of the Jersey cow is not found in the show-ring at the Royal, at least among the winners. Her average weight is 830 lb., her average yield of milk about 450 gallons, or larger than the average yield of bigger stock, and yet she sometimes reaches 1000 to 1100 gallons in the year. Her colour is fawn or golden, golden fawn, silver grey, or mulberry. Her average yield of fat is nearly 5 per cent., sometimes reaching 7½ per cent. or more; the other solids reaching nearly 9½ per cent.; but we shall presently see what first-class cows can do. The Jersey is small in size and is fed for exhibition, though fine and soft in skin, but poorly fleshed. We must not assume, however, that the cows with high-bred points are those which yield the milk. The deepest milkers are not of exhibition form, and seldom win a prize outside the Butter Tests; their frame is large and coarser by comparison, and yet we must not confound them with the common Jersey stock one often sees, the scrubs and wasters of a noble breed, with unlevel spines, defective udders, widespread horns, coarse shoulders, and legs too crooked to be true.

In Jerseys of the highest exhibition type the horns are bent as though each point attempted to reach its neighbour; yellow at the base and tipped with black. The muzzle, like the tongue, is black, the ears are thin, the inside yellow and somewhat oily, in these respects resembling the udder and the tail. The face is dished, the neck is slender, while the shoulder is almost imperceptible; the ribs are well sprung, giving ample room for the organs of the body to play their part with freedom; the back is straight until we reach a point behind the hips where straightness fails in almost every cow we see. The Jersey is an ideal milk and butter cow; narrow in front and wide behind, especially from hip to hip and between the buttocks. There is, however, greater depth, especially from loin to flank. These points are most essential that the udder may be wide and great in length, it should be globular in shape, the teats being placed at equal distances and wide apart, while medium in size. The best milkers have a large milk vein, while Island breeders in particular regard the richness of the colour of the udder, ears, and insides of the thighs, especially if accompanied by an oiliness of skin, as indicative of a rich and liberal milker.

If we examine the records of the milking powers of a hundred cows, good and indifferent, we shall find that few yield milk which is poor in fat, however large or small the quantity. There may be other records, but

we take one which we remember well as an example. This was the London champion cow of 1889, named Baron's Progress. Her morning's milk contained 7·94 per cent. of fat and 8·55 per cent. in the evening. These figures are most remarkable, the evening's milk being almost equal to producing 1 lb. of butter for every gallon yielded. If we place a tiny drop of Jersey milk beneath the microscope and make comparison with other breeds, we find that, excepting the sister cow the Guernsey, the fat globules are much larger. It was found by Dr. Peter Collier in his very numerous observations that the average diameter of the globules of the Jersey was $\frac{1}{9631}$ inch and the ratio size 103, whereas in the case of the shorthorn cow the average diameter was $\frac{1}{11,274}$ inch, the ratio size being 121. Although the Guernsey stands first upon the list owing to her better average, the largest globules are present in the Jersey milk. It has been suggested that the rich yellow of the butter is owing to the colour of the globule, and that its waxiness may also be attributed to its greater size.

Unfortunately the Jersey is not a butcher's breed, and here lies one of the mistakes of Jersey breeders. The Guernsey cow, as we shall see, is better fleshed, and if her yield is smaller the fact is owing to her want of patronage. A cow which fails to carry flesh is of little value to her owner when, owing to accident or age, she fails to milk, but as in other breeds there are Jerseys without number, bred from wasters like themselves, which yield so little milk that farmers are disgusted and are led to shun the Jersey altogether.

It is well known that in Jersey Island there is no other breed of cow and that none can be imported. The Jersey farmer's aim is to produce the best for English buyers, but it should be noted that owing to the change of climate the risk involved is great, unless the greatest care is exercised for twelve to fourteen months. To this we add a word of caution. A cow born in the Island should be most carefully examined, for breeding on most careful lines the Jersey man prefers to keep the best, and thus the dealer brings to British shores the culls, for which he asks big prices. The English Jersey is a larger and a coarser cow, she stands all climates well, for we have seen her thriving in the far Canadian West, and can be bred to reach the highest yields of milk and butter yet attained, but only by selection. The average amateur who wants a Jersey for her milk and cream may obtain all that he requires without resorting to the Island cow; he will be also wise in paying more attention to the milk supply than to the fancy points. At the London Show the Jersey cow, like other breeds, competes in double classes—the one for beauty on inspection, the other for her yield of milk. It has been shown that by this dual system fancy points have little, if any, connection with the economical properties of the cow.

We have remarked upon the want of meat in relation to this breed, but as bull calves arrive the better plan to make them pay their way is to feed them for the sale of veal, their early value in the market being very small indeed. Next, with regard to milk and cream. For those who drink milk in extra quantities the milk goes further than an average sample. For most consumers it is too rich in cream and other solids, and may in consequence be slightly thinned with separated milk or even water. For table cream no other can excel it, whereas for cheese production it makes the most per gallon and yields the highest price. The writer was present at the extensive trials of dairy stock at the Chicago Exhibition in 1893. Three breeds competed, the Jerseys, Guernseys, and shorthorns, twenty-five of

each. The following table shows how high the Jersey stands when compared with cows of the shorthorn breed:—

Breed.	Lb. Milk.	Lb. Cheese.	Lb. Whey.	Lb. Milk per lb. Cheese.
Jersey	13,296	1451	11,578	8·11
Guernsey	10,938	1130	9,666	9·6
Shorthorn	12,186	1077	10,839	11·3

In a similar test, made at the New York Experiment Station with milk which was rich in fat, the quantity of cheese produced averaged 12·35 lb. per 100 lb. of milk, and reached as high a figure as 14·2 lb., the average being equivalent to 8·09 lb. of milk per lb. of cheese. It has been found in American experimental work that the use of rich milk in cheese production is followed by a smaller percentage loss of fat than when the milk is of lower quality. We have already referred to the famous Baron's Progress which produced 3 lb. 5 oz. of butter in one day in 1889 at Islington. Her measurements, which were taken by the writer, were as follows:—

	Inches.
Height of hips	50
Length	87
Girth round middle	91
Girth round shoulder	72
Girth across hips	16
Hip to tail	20

So far it has been difficult to ascertain what are the possibilities latent in the Jersey breed. In many cases we find cows yielding no more than 300 gallons of milk, while in others, and we may especially mention Lord Rothschild's herd, we find eighteen cows averaging 745 gallons per head per annum, one of which yielded 1066 gallons, while another cow has averaged during four years 884 gallons per annum.

The following are some of the highest yields of butter in public tests:—

Exhibitor.	Cow.	Yield. Lb.	Yield. oz.
J. Brutton	Baron's Progress	3	5
Dr. Watney	Blackberry	3	9¼
J. R. Corbett	Em	3	4
Do.	Do.	3	4¾
G. L. Gruchy	Karnak	3	6½
P. J. Bree	La Sente Marionette 2nd	3	4½
Dr. Watney	Sharab	3	9¾
Lord Braybrooke	Sundew	3	6¾
Col. Hankey	St. Brelader Lady	3	4

The productive properties of the breed, if we may be guided by experience, depends first upon the blood or strain, and next upon the condition

in which the cows are kept and the manner in which they are fed and managed. In the judgment of the writer, the type of Jersey exhibited in the show-ring is not adapted to the production of large quantities of milk; the cow should carry more flesh, while her rations should contain a larger proportion of the albuminoids of food. It is asserted by some supporters of the breed that the period of lactation is longer than that of other cows, and that she consumes a smaller quantity of food. It would be well if data were forthcoming in support of the first assertion, for we have not found this to be generally the case in an experience of some twenty years.

That a small cow weighing 850 lb. consumes less than a large cow of 1250 lb. is quite natural, but a highly productive Jersey must be well fed and possess an appetite equal to the occasion. And this is generally the case, for a healthy beast is gentle in her habits and not dainty in her feeding. It must be remembered that the larger the cow, the larger the proportion of food required as her maintenance ration. For instance, it has been laid down by Wolff that a cow weighing 1000 lb. requires 15·4 lb. of digestible dry matter, which is contained in about 24 lb. of organic matter, daily, this quantity being consumed for maintenance alone. A large cow, therefore, weighing 1250 lb. would require 30 lb. of organic matter of similar character, whereas a Jersey weighing 830 lb. would only require 20·4 lb., and these figures have been more or less sustained by careful observations both in Germany and America. Thus, for maintenance alone, a large shorthorn requires about 25 per cent. more organic matter in her ration than a Jersey cow of average size. There is apparently a difference of nature's provision between the digestive powers of the Jersey and of cows of other breeds, inasmuch as there are few records, these being chiefly confined to the Dutch and shorthorn breeds, in which such good use is made of the food consumed.

Mr. Ernest Matthews, one of the best authorities on the Jersey, is of opinion that they originally came from Normandy, and he quotes a remark made by the Rev. Philip Falle, in 1874, that the Island cow was superior to the French; but, as Mr. Matthews says, it was not until an article was published by Colonel Le Couteur some sixty years ago that any writer had suggested how that superiority was attained. During the earlier part of the last century several writers spoke highly of the Jersey breed, but so far as we have found there is no evidence of its origin. There are many records of heavy yields and high quality of milk, but, as in the case of colour and of name (for Jerseys are still termed "Alderneys" by many people), so it was with milk and butter. The time had not arrived for the development of the chemistry of the dairy, nor indeed for the establishment of scales of points. There is a marked difference in the conditions of eligibility for entry in the Herd Book as between the Jersey and the English societies. In England a calf may be entered on condition that her sire and dam are already in the Herd Book, whereas in Jersey judges are appointed to examine the progeny of any Herd Book stock which is proposed for entry. Thus the islanders who have bred their cattle on Herd Book lines for three-quarters of a century take greater care to exclude inferior stock. Again, the islanders have other rules of great importance which remind us of the regulations applied in Switzerland at the National Exhibition to some varieties of stock. The animals are examined outside the show, and none are allowed to enter and compete for prizes unless they are considered worthy by the judges who inspect them. Again, in Jersey, before a bull can qualify for entry, his dam must be examined, that her merits may first be taken into consideration. When an animal proposed for entry is passed by the judges for the Herd Book, it obtains a qualification, so that before

competing for a prize the owner has already obtained the opinion of the judges. Thus particular rules exclude the weeds, and there are many, which are so often sold above their value by owners of Herd Book stock.

The standard of points of the English Jersey Cattle Society is as follows:—

Scale of Points for Bulls in the Island Herd Book.

Articles.		
1.	Head broad, fine; horns small and incurving; eye full and lively	5
2.	Muzzle broad, encircled by a light colour; nostrils high and open; cheek small	5
3.	Neck arched, powerful and clean at the throat	7
4.	Withers fine; shoulders flat and sloping	5
5.	Lung capacity as indicated by depth and breadth immediately behind the shoulders	8
6.	Barrel deep, broad, and long, denoting large capacity, ribs rounding in shape	12
7.	Back straight from withers to setting of tail; croup and setting on not coarse	10
8.	Hips wide apart, rather prominent and fine in the bone	5
9.	Loins broad and strong	5
10.	Legs rather short, fine in the bone, squarely placed and not to cross or sweep in walking	5
11.	Rudimentary teats squarely placed and wide apart	5
12.	Tail thin, reaching the hocks, with good switch	2
13.	Well grown according to age	3
14.	Hide thin, loose, and mellow	5
15.	Showing a yellow colour on skin and horns	3
16.	General appearance: denoting a high-class male animal, typical, and of a class suitable for reproduction	15
	Perfection	100

Scale of Points for Cows.

Articles.		
1.	Head fine; face dished; throat clean	4
2.	Nostrils high and open; muzzle encircled by a light colour	2
3.	Horns small and incurving; eye full and placid	2
4.	Neck straight, thin, and long, and lightly placed on shoulders	5
5.	Lung capacity as indicated by width and depth through body immediately behind the shoulders	3
6.	Barrel deep, broad, and long, denoting large capacity; ribs rounding in shape	10
7.	Back straight from withers to setting of tail; croup and setting on not coarse	6
8.	Hips wide apart, rather prominent and fine in the bone	2
9.	Hind legs squarely placed when viewed from behind and not to cross or sweep in walking	2
10.	Tail thin, reaching the hocks, good switch	2
11.	Udder large, not fleshy, and well balanced	10
12.	Fore-udder full and running well forward	10
13.	Rear-udder well up, protruding behind and not rounding abruptly at the top	8
14.	Teats of good uniform length and size, wide apart and squarely placed	7
15.	Milk veins large and prominent	3
16.	Richness as indicated by a yellow colour on horns, chine, and inside of ear	3
17.	Skin thin, loose, and mellow	4
18.	Growth	3
19.	Withers fine	4
20.	General appearance: denoting a high-class and economical dairy cow	10
	Perfection	100

With regard to the Butter Tests, for which the English Society provides

medals, money, and certificates of merit, and which can only be gained by cows entered in the Society's Herd Book, it may be mentioned that one point is allowed for every ounce of butter produced, one point for every completed ten days since calving, deducting the first forty days, the maximum allowance for the period of lactation being twelve points. Fractions of ounces and incomplete periods are added in the form of decimals, but where cows obtain the same number of points the prize is awarded to the cow which has been in milk for the longest period. The test lasts for twenty-four hours. There is a prize awarded for the cow yielding butter of the best quality, but neither medals nor prize money are awarded where cows under five years old fail to obtain 30 points, or where cows exceeding five years fail to obtain 35 points. Every cow is entitled to a certificate of merit which obtains 30 points in the one case and 35 points in the other. A recommendation is appended that exhibitors should test their cows at home before entering them for the public test. The competing cows must be milked clean at the hour prescribed on the evening of the day preceding the test, and in the presence of the judges, their deputies, or the stewards. This time must be exactly twenty-four hours before the last milking in the test. The milk drawn during the test must be separately weighed, registered, and labelled, and both the separated and butter milk must be retained until the awards are completed or until such time as the judges may direct. In churning the separated cream the temperature of the dairy must be observed and the cream churned between 52° and 54° Fahr. The time occupied in churning and the temperature of the buttermilk when churning is finished must be taken. These are points of such importance, being as they are the result of so much experience, that they are included in these remarks. The following are the forms which the judges require to fill up in conducting the tests:—

CHURNING.

Time and Temperature.

No. in Catalogue.	Name of Cow.	Time.			Temperature.		
		Churning began.	Churning finished.	Duration of Churning. Minutes.	Dairy.	Cream and Churn.	Butter-milk when Churning finished.

FORM TO BE FILLED UP BY THE JUDGE.

Occasion ____________________ *Date* ____________________

No. in Catalogue.	Exhibitor.	Name of Cow.	Breed.	Live Weight lb.	Date of Birth.	Date of last Calf.	No. of Days in Milk.	Milk Yield.			Butter Yield.	Ratio, viz. lb. Milk to lb. Butter.	Colour and Quality of Butter.		No. of Points for Butter.	No. of Points for Lactation.	Total No. of Points.	Awards.
								Morning. lb. oz.	Evening. lb. oz.	Total. lb. oz.	lb. oz.		Colour.	Quality.				

The following is an analysis of the Society's butter tests from 1886 to 1906:—

Cows' Ages.	Number tested.	Average Days in Milk.	Average Milk Yield.	Average Butter Yield.	Butter Ratio.
			lb. oz.	lb. oz.	lb.
Over 1 and under 2 years	2	34	15 2	0 13	18·43 about 15 pints milk per lb. butter.
,, 2 ,, 3 ,,	133	95	25 3	1 6¼	18·15 ,, 15 ,,
,, 3 ,, 4 ,,	262	96	30 4	1 9¾	18·66 ,, 15 ,,
,, 4 ,, 5 ,,	392	100	31 12¾	1 11	18·81 ,, 15 ,,
,, 5 ,, 6 ,,	383	99	33 5¼	1 12¾	18·48 ,, 15 ,,
,, 6 ,, 7 ,,	365	104	33 4¾	1 13½	18·08 ,, 14 ,,
,, 7 ,, 8 ,,	293	103	35 0¼	1 14	18·64 ,, 15 ,,
,, 8 ,, 9 ,,	195	107	35 3	1 13¼	19·15 ,, 15 ,,
,, 9 ,, 10 ,,	128	122	33 14¼	1 13	18·62 ,, 15 ,,
,, 10 ,, 11 ,,	72	108	35 9½	1 14½	18·67 ,, 15 ,,
,, 11 ,, 12 ,,	37	104	35 2¾	1 13¾	18·84 ,, 15 ,,
,, 12 ,, 13 ,,	21	130	33 0	1 11	19·57 ,, 16 ,,
,, 13 ,, 14 ,,	7	117	38 4½	1 15¼	19·62 ,, 16 ,,
,, 14 ,, 15 ,,	3	99	35 9¼	1 1½	32·22 ,, 26 ,,
,, 15 ,, 16 ,,	2	119	32 9	1 11	19·11 ,, 15 ,,
,, 16 ,, 17 ,,	1	235	26 4	1 10¼	16·00 ,, 13 ,,

It will be observed that 2296 cows between the ages of two years and seventeen years have been tested, the average quantity of milk obtained during the single day throughout the whole of this number is 31 lb. 3½ oz., or more than 12 quarts per day, while the average quantity of butter obtained was 1 lb. 10 oz., showing that 19·44, or less than 2 gallons of milk, was required to make each pound of butter. These figures are of very high importance, especially when we notice that the average number of days which the cows had been in milk was 110, so that in less than a third of a year the cows had produced nearly 350 gallons of milk, which is quite as high as the average yield of the inferior milking cows in the British Islands during a whole year.

Although much of the best work performed by breeders of the Jersey was accomplished by men like Philip Dauncey (selections from whose stock have formed the basis of some of the best herds in Canada and the United States), Mr. Baxendale, and the late Lord Braybrooke, none have equalled Dr. Watney, who stands at the head of Jersey breeders of to-day, from the point of view of the production of milk and butter. Dr. Watney's herd was established in 1888, largely by the aid of Dauncey and Braybrooke blood. In the year 1895 Dr. Watney found that he had almost doubled the average yield per cow within the previous twelve years. In 1892 the butter yield averaged 266 lb. per cow, whereas in 1904 it reached 463 lb. Such is a testimony to the breeder's art. During the previous three years Dr. Watney won thirty-three out of the fifty-four medals which were awarded by the English Jersey Cattle Society, including fourteen of the eighteen gold medals, in addition to a hundred certificates and nearly a hundred other prizes. In the year ending September 1905, twenty-two cows averaged 453 lb. of butter, and it was found—and this is a fact of prime importance to the owners of dairy stock—that the difference between the actual yield as shown by the Gerber tester and the churn respectively did not vary as a rule more than 1 per cent. Several cows have from time to time exceeded the figures quoted, and among these were Sharab, a winner of four gold

medals, which produced 600 lb. of butter in a year, and Guenon's Lady, 619 lb.; while as to milk, some of the cows in Dr. Watney's herd have produced a quantity equal to their own weight in from sixteen to eighteen days; thus Sharab and Red Maple produced 56 lb. in a single day and 112 lb. in two consecutive days when on exhibition, while these two cows and Opale have performed the feat for such small beasts of yielding 1000 gallons in the year. It is needless to quote any further examples of what has been accomplished, but if it is possible for Dr. Watney to obtain such results, it is equally possible for others if the same thought and energy are devoted to this most valuable work. It may be pointed out that a cow yielding 600 lb. of butter which sells at 1s. 4d. a pound returns £40 for butter alone, but if we add to this figure a minimum yield of separated and butter milk (say 750 gallons) and value it at 1½d. a gallon, we add £4, 13s. 9d. to a total which needs no further comment on the breed.

During several conversations with Dr. Watney, in response to an invitation to see his herd, we arrived at the conclusion that he is a Master of his subject, and that his views are worthy of the closest attention of breeders of all classes of dairy stock. We cannot, however, do better than refer, however briefly, to the most important features of the science of breeding as expressed by him in the *Live Stock Annual* of 1903, and to his remarks to ourselves in a form which must of necessity be condensed. Dr. Watney thinks that the only method of obtaining a herd of heavy milk and butter makers is by breeding them. He takes it as an axiom that careful and patient breeding with a single object will be followed by an almost certain measure of success. This view had been already proved in the production of beef and mutton, indeed of the whole live stock of the farm. Dr. Watney himself has proved it by the astonishing experience to which we have referred. Nor should we exclude the islanders of Jersey, who have produced cattle of wonderful milking power for so long a period. Again, it is remarked that it is quite rare to find a Jersey beaten as a butcher cow, while, weight for weight, she is equal to any other breed kept for the production of milk, if we take into consideration her period of lactation. Again, the same experience shows that the powers acquired by well-bred stock will be transmitted to their progeny if the process of breeding has been sufficiently long and always conducted with the same object. We find in the celebrated Lincoln reds of Mr. John Evans, as in Dr. Watney's Jerseys, that as time goes on the qualities of the parent stock are impressed not only upon their young, but that impression continues, we may almost say indefinitely, so long as the same line is followed and the object is the same.

Jersey cattle, as a rule, are all producers of rich milk (*i.e.* milk containing a high percentage of butter fat), and yet the percentage differs not only as between one cow and another, but between cows of different families. The fat produced in the milk of a given cow Dr. Watney finds to be fairly constant, assuming that she is well fed, kept warm and in good health. Like ourselves, he finds that the per cent. of fat in milk is not to any great extent determined by the character of the food she eats. Nor does it follow that the winner of a butter test is the best cow in the herd; her annual record may be lower than that of others. This is an interesting point, and applies to other breeds. The value of a cow does not depend upon her yield when at her best; the best cows in a herd are those which milk the longest and produce the largest quantity of butter. In breeding Jerseys the practice of inbreeding is regarded as a dangerous policy, for although success may be achieved, it may be at the cost of health or constitution. When comparison

is made between the exhibition cows in an important show and those competing in the butter test, it will be found that, as a rule, the former have the largest udders. Large size in the udder does not decide the quantity or quality of milk, nor do the best competitors in butter tests produce so large a quantity of butter when at home; for special yields of milk or butter are to a large extent obtained by forcing—a practice which continued would possibly derange the cow, for all depends upon a sound digestion.

There are many points of value, nay of great importance, which none but long-experienced breeders note; thus, for example, many cows produce few heifer calves, while others which produce more heifers fail to impart the virtues of their parent. To-day the Jersey may be divided into two varieties—the exhibition cow, bred for points of beauty; and the household Jersey, which is bred for milk and butter. Those who are acquainted with the art of breeding and its many disappointments may be induced to believe the fact that it is almost impossible to find both features at their best in a particular cow. Where can the breeder find the stock to build the dual Jersey?

Dr. Watney finds that in rearing stock the milk should be diluted and calves never over-fed; yet no herd of cows require better feeding. We have seen the herd at Buckhold quite knee-deep in pasture grass in summer and yet receiving 2 lb. of corn per day, while in winter they obtain what hay they like—and that the best—with 15 lb. of parsnips and good-hearted cabbage, 10 lb. of cake and corn when milking well, and water as they choose to drink it.

Joint-ill.—Early literature of animal diseases yields evidence of the existence among young animals of different species of a condition known to British breeders as "joint-ill," "joint-evil," "joint-felon," "navel-ill," or "scrofulous joint disease," and technically as "specific arthritis," "rheumatic arthritis," or "pyæmia," as well as by some purely provincial names such as "schole," used in Norfolk, etc. The malady is more commonly observed in foals and lambs, less so in calves and young pigs. It is probably always acquired before or within the first few days after birth, and, as a rule, manifests itself in this period. In rarer instances symptoms may not be observed for months. Its effects, especially on foals, are often fatal or such as to render its subjects worthless. Sometimes it occurs as an isolated case in a stud, flock, or herd, but often many animals are simultaneously affected, when matters become alarming, especially if, as is not uncommonly the case, valuable animals are the subjects. Deaths of 30 per cent. of foals have been recorded in some British studs, and about the same proportion of lambs in a flock.

Joint-ill affects young animals irrespective of breed, but its incidence is probably more marked among pure-bred, high-class foals than the coarser cross-breds. This liability would seem to depend largely on the manner of the breeding operations, especially the congregating at the stud of mares from many sources. Previous to recognition of its true nature, the disease, when once appearing in a situation, often exercised an abiding influence, and became a great menace to breeding there. The records of some foreign Government studs indicate its existence for a hundred and twenty years, in some seasons causing extensive losses, and an average for the whole period of 5 per cent. of all foals born.

In the disease, as occurring in animals of the various species, there are some points in common. It is not, however, proved that the cause is

identical in all species, but for our present purpose there appears no reason for describing separately the condition in the several species.

With regard to the cause of joint-ill, great variety of opinion has been expressed. Like most other diseases manifested in the very young, this has been regarded as a hereditary constitutional condition, belonging to some strains of blood or acquired by residence of the mother in special situations. In-and-in breeding; "scrofula" or tuberculosis of parents; irregular and improper feeding and work; overheating of the dam; cold, damp, east winds; and many other matters, have been advanced as causing this malady, while the symptoms of lameness and swollen joints have been attributed to rheumatism. It is, however, proved by experiment and closer observation of the living and the dead that it is a contagious disease, and that if communicated from the parent to the offspring, it is not of a tuberculous nature. Joint-ill is due to a microbe, the entrance of which usually takes place after birth. Certain circumstances appear to indicate that the contagium may enter the system of the fœtus while in the womb, or in the act of being born.

This view seems supported by evidence of joint disease in foals at birth. However, whether contracted in the womb, during parturition, or subsequent to birth, there is ample reason for believing that the microbe causing it usually enters at the navel. Anything which retards the closing of the navel of the newly born animal must predispose it to any disease whose germs ordinarily enter through this channel. In this way the health of the mother may have some influence in the incidence of the disease. It has been stated that 70 per cent. of the cases of joint-ill are met with in male animals, and suggested that this is due to the fact that the urine from the male organ deters healing of the navel. At most, such matters can only favour the occurrence by providing the means of entrance or suitable conditions for development of the microbes on which the disease processes depend.

The germs are believed to settle and multiply in the clot in the broken end of the blood vessels at the navel, to be carried away by the blood stream, and to settle in the parts of the system for which they have a special predilection, namely, the joints, where they set up those changes which have given the disease its name. It often happens that the germs settle in other parts of the system and set up disease in them. There is some reason for supposing that the disease may follow swallowing the microbe, or its entrance through wounds other than the open navel. Sufficient is not yet known about the individuality of the germ which causes joint-ill to allow of an opinion as to whether it is specific or obligatory, or if it can live and multiply apart from an affected animal. The comparatively limited distribution of the affection, its persistence in some situations where disinfection has not been adopted, and the fact that in other situations the navels of animals kept under most insanitary conditions often remain open for long periods without becoming infected, all point to the view that the germ which causes joint-ill is not one of those ubiquitous organisms which produce abscesses under ordinary circumstances. This suggests that the germs may live for a long time outside the animal body, or in the womb and genital passages.

The onset of the *symptoms* and their severity are subject to great variation. They may be evident a few hours after birth or be delayed for months. The earlier they are noticed the more serious the attack, and a large proportion of foals showing symptoms in the first week of life usually die in the course of a few days. The affected foal is first noticed to

move with difficulty, or to be constantly lying down or standing in one position. Debility is marked, appetite is lost or impaired, the coat is dry and hard, and the little animal "tucked up." The temperature is elevated, the flanks often beat quickly, and sometimes a little discharge may be noticed from the eyes and nostrils, which often gives the impression of a "chill." The navel may be open, swollen, and discharging matter, and though sometimes healed on the outside, its neighbourhood is inflamed. Hot painful swellings may appear in the neighbourhood of joints and elsewhere, and reach a considerable size. Any joint may be affected, though perhaps more commonly the hocks, stifle, hips, or knees are involved. The complexion of the case may be materially altered by changes due to the action of germs in internal parts. Diarrhœa is usually a prominent feature sooner or later in course of the affection, and the pulse, throughout frequent and weak, becomes faster and weaker as the disease advances. The foregoing specially refers to foals. In lambs the symptoms are of the same character, but they more frequently appear relatively a little later after birth, and the systemic disturbance usually is not so great, while the swellings at the joints perhaps more rapidly develop into abscesses, and burst, discharging thick white matter. In early occurring cases of a milder type, the symptoms will be less marked, and recovery may take place. It is taken that in the average cases the manifestations occur from three to twenty days after birth, and that the disease runs through its course in from three days to two weeks. The course may, however, be prolonged, and some subjects "hang fire" for months; but in such cases the subject is often not worth the trouble of rearing, some permanent joint trouble remaining. At other times the disease may not manifest itself for several months after birth, though usually animals so affected may have been noticed not to be good doers. The later the occurrence of symptoms the less the constitutional disturbance. Lameness and a swollen joint are usually the first indications, and a considerable proportion of such cases recover, though many never become valuable animals, while in some a succession of abscesses make their appearance, and death may result after a prolonged illness.

Post-mortem examination shows that abscesses may occur in any part of the body; the chest, the abdomen, and their viscera as well as the joints may contain much matter.

The curative treatment of the very young animal affected with joint-ill does not afford much hope of success. The prospect is somewhat better in the case of the older patient, but under any circumstances the adoption of the best measures calls for all the skill of the most expert, whose services should be sought at the earliest moment.

Preventive measures, based on recognition of the fact that the disease is contagious and that the contagion usually enters through the open navel, are more or less successful according to the thoroughness with which they are carried out. Allowing the pregnant mare to live and foal outdoors averts the great danger of contaminated stables, etc. If the mare has been in any place where joint-ill is known to exist, the precaution of sponging her passages, back parts, etc., with some antiseptic a few days before foaling is advisable. The disinfection of loose-boxes, etc., has been referred to in the article on Foaling. The practice of tying the navel-cord or *umbilicus* has much to recommend it, though it is absolutely necessary that no germs of joint-ill shall be imprisoned, for if so the chances of the subject taking the disease are increased by the operation. The cord should be tied immediately after birth either by the veterinary surgeon or some one instructed by him, who should have at hand some antiseptic solution with which to

thoroughly cleanse the parts, and a ligature of string, silk, or gut, which has been kept in antiseptic solution, to tie the cord. The navel may be soaked in some antiseptic after the cord is tied, and then dusted with some disinfectant powder. Foals with their dams should be kept apart on the earliest suspicion of being affected, and their attendant should not mix with other foals.

On the first appearance of joint-ill in lambs, the affected should be removed and isolated or slaughtered immediately. If practicable, the remainder of the ewes should be turned on to a fresh pasture and allowed to lamb in the open. The disease in lambs appears to be often associated with a contaminated lambing pen, and, though when joint-ill is threatened, lambing in the open is probably best, if this is not regarded practicable a fresh pen must be provided, and according to some observers a new shepherd. At any rate the hands, garments, and anything which might have been contaminated by the previous cases, unless disinfected, should not be brought into contact with the navels of other lambs. An intelligent review of the whole subject of pregnancy and parturition, the care of the newly born, and the accidents to which they are liable, indicate only such interference with nature as is sufficient to avert the dangers established by artificial conditions. Our own experience leads us to the conclusion that foaling and lambing in the open field, with the minimum of handling by the groom or the shepherd, is much freer from danger than where the act takes place indoors or in the pen, and great anxiety as to the time and manner is manifested with the very best intent by attendants.

END OF VOL. II.

Printed by Morrison & Gibb Limited, *Edinburgh*